FOREST RESOURCES COMMISSION

Background Papers - Volume 2

Gaining Insight into Forest Land Use Conflicts with Decision Analysis
- T. McDaniels, PHD

The Use of Cost-Benefit Analysis to Allocate Forest Lands Among Alternative Uses
- W. T. Stanbury, Dr. Ilan Vertinsky, and H. Thille

A Review of the British Columbia Crown Land Allocation and Management Planning Process
- Dorli M. Duffy

Multiple Accounts Analysis and Evaluation of Forest Land Use Conflicts
- Dr. Thomas Gunton, G. C. Van Kooten, and S. Flynn

Economic Valuation of Non-Market Values for Forest Planning
- Dr. Thomas Gunton

Toward Sustainable Water Planning and Management in British Columbia
- Dr. J. C. Day and J. A. Affum

FOREST RESOURCES COMMISSION

Background Papers - Volume 2

Gaining Insight into Forest Land Use Conflicts with Decision Analysis
- T. McDaniels, PHD

The Use of Cost Benefit Analysis to Allocate Forest Lands Among Alternative Uses
- W. T. Stanbury, Dr. Ilan Vertinsky, and H. Thille

A Review of the British Columbia Crown Land Allocation and Management Planning Process
- Dorli M. Duffy

Multiple Accounts Analysis and Evaluation of Forest Land Use Conflicts
- Dr. Thomas Gunton, G. C. Van Kooten, and S. Flynn

Economic Valuation of Non-Market Values for Forest Planning
- Dr. Thomas Gunton

Toward Sustainable Water Planning and Management in British Columbia
- Dr. J. C. Day and J. A. Affum

The views expressed in independent reports prepared for the Forest Resources Commission are those of the authors and not necessarily those of the Commission. They are published in their entirety for the use and interest of the public as background studies to the April 1991 Report of the Commission to the Minister of Forests.

GAINING INSIGHT INTO FOREST LAND USE CONFLICTS WITH DECISION ANALYSIS

BY
T. McDANIELS, PHD
McDANIELS RESEARCH LTD.
VANCOUVER, BC
and
GRADUATE SCHOOL OF PUBLIC AFFAIRS
UNIVERSITY OF WASHINGTON
SEATTLE, WA

PREPARED FOR:
BRITISH COLUMBIA FOREST RESOURCES COMMISSION

FINAL REPORT
October, 1990

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

1.1 Context 1
1.2 Objectives and Structure 2

2.0 CHARACTERISTICS OF FOREST ALLOCATION DECISIONS 5

3.0 AN ANALYTICAL TOOL FOR ADDRESSING COMPLEXITY IN FOREST ALLOCATION DECISIONS 9

3.1 Overview 9
3.2 Methods of Decision Analysis 10
3.3 Applications of Decision Analysis in Forestry 13

4.0 STRUCTURING DECISIONS REGARDING FOREST LAND ALLOCATION

4.1 Overview 14
4.2 Defining the Decision To Be Made 14
4.3 Structuring Objectives 16
4.4 Constructing Alternatives 21
4.5 An Example Analysis 21

5.0 ASSESSING CONSEQUENCES OF FOREST LAND USE ALTERNATIVES

5.1 Overview 24
5.2 Generic Issue in Analysis of Forest Management Options 25
5.3 The Default Case 26
5.4 What Possibilities May Be Created? 29
5.5 The Implications of Approaches to Setting Harvests 30
5.6 How Should Uncertainties Be Considered? 34
5.7 The Example Analysis Revisited 36

6.0 DETERMINING PREFERENCES FOR FOREST LAND USE DECISIONS

6.1 Overview 38
6.2 Preferences in Forest Allocation Decisions 40

6.3 Value Tradeoffs 41
6.4 Risk Attitude 43
6.5 Time Preference 44
6.6 The Example Revisited 45

7.0 EVALUATING ALTERNATIVES FOR FOREST LAND USE 47

7.1 Overview 47
7.2 Analytical Practice 47
7.3 Effects of the Process 48
7.4 The Example Revisited 49

8.0 CONCLUSIONS 51

1.0 INTRODUCTION

1.1 Context

Decisions regarding the allocation of forest land to alternative uses are among the most divisive, hard fought, and complex choices facing forest managers. The best publicized of these decisions is the whether to preserve or harvest certain areas of old growth forest (Caulfield, 1990). Similar, though less publicized, conflicts arise over commercial forest harvests in community watersheds, the allocation of land for subsistence farming or commercial forestry, and constraints on forestry activities to enhance wildlife, fisheries, or aesthetics.

One major reason for controversy is that these decisions involve dramatic examples of conflicting values. Withdrawals of land from the commercial forest base are perceived by some as strikes at the livelihoods of workers in small rural communities, and at the economic basis of operations by major corporations. Conversely, decisions to allow commercial harvest in pristine wilderness areas are perceived by others as a threat to the survival of ecosystems and a loss of areas with great aesthetic and spiritual importance. These disagreements in values often lead to arguments about facts: the consequences of alternative management actions and the likelihood these consequences will occur. Yet little information is available regarding insightful ways to approach these forest management questions that will inform decision makers about public values, science facts, and sources of uncertainty within a structured framework for comparing alternatives.

Conflicts over commercial forest activities in British Columbia have escalated dramatically during the 1980s. Two factors at least partly explain this increase:

(1) Commercial forestry operations have already harvested much of the province's old growth forests, particularly on the coast. Many of the remaining areas are viewed as having high recreational, spiritual, and ecological value, and are therefore advocated for preservation.

(2) A major shift in public values, identified in virtually all polls and opinion forums, that show environmental issues (particularly forestry) rising as a predominant public concern (Vancouver *Province*, 1989).

Another important factor is that the province of British Columbia maintains ownership of over 95 percent of the commercial forest land and virtually all remaining old growth forest, as a result of the patterns of land alienation and tenure in Canada (Pearse, 1988). Thus, the speed and location of forest harvest is a matter of public policy, which could be quickly changed by government action.

The Forest Resources Commission of British Columbia has been established to advise the Minister of Forests on a wide range of forest policy issues, including forest land allocation issues. Recognizing the need for analytical approaches to help clarify these conflicts, the Forest Resources Commission has sponsored a set of background studies that will lead to a summary report regarding approaches to forest land use allocation. This report is one of the set of background studies expected to contribute to the summary report.

1.2 Objectives and Structure

The overall objective of this report is to explore the potential of decision analysis as a tool for gaining insight into complex decisions regarding forest land allocation. In brief terms, decision analysis is an analytical tool, or technology, for gaining insight into complex decision problems that involve conflicting objectives and many sources of uncertainty. Keeney has defined decision analysis in an intuitive vein as "a formalization of common sense for decision problems which are too complex for informal use of common sense", or more technically as "a philosophy articulated by a set of logical axioms and a methodology and collection of systematic procedures, based on those axioms, for responsible analyzing the complexities inherent in decision problems" (Keeney, 1982). Decision analysis has been employed as a normative framework for analyzing complex decisions in a wide variety of contexts, ranging from corporate strategy to medical decision making to health and safety regulations (Howard and Matheson, 1983). While decision analysis has been applied in specific types of forestry problems, such as the selection of silvicultural treatments (Brumelle, Carley, Vertinsky and Wehrung, 1988; Martell and Fullerton, 1987; Pearce, McDaniels and Swoveland, 1990), the approach has not been widely employed in the context of land allocation decisions.

The overall objective of this paper can be cast in terms of three subobjectives:

(1) review the concepts and approaches of decision analysis and clarify how they relate to forest land allocation decisions;

(2) discuss two aspects of land allocation decisions in detail to illustrate the use of decision analysis techniques. These include methods for structuring objectives and methods for evaluating alternatives; and

(3) identify directions for future work that will involve case studies of decision analysis as applied to aspects of forest land allocation conflicts.

The structure of this report proceeds in the following manner. Section 2 reviews the characteristics of forest land allocation choices that make these decisions particularly difficult. After that, Section 3 provides an introduction to decision analysis, indicating how the complexities identified in Section 2 are handled within this approach. Sections 4 through 7 discuss specific steps in the decision analysis approach and key issues within forest allocation decisions. Finally, Section 8 presents conclusions and recommendations.

A clarifying note is in order regarding the kinds of forest land use decisions considered in this report. In the discussion that follows, emphasis is deliberately placed on decisions involving allocation of old growth forests to preservation or harvest. That emphasis has been chosen because of the predominant role of these decisions within forest policy debates in British Columbia and the Pacific Northwest states. Nevertheless, the principles and approaches discussed here are relevant to virtually any decision involving questions about the conduct of forest harvests. An essential feature of such decisions is the inescapable need for tradeoffs between economic benefits (in the form of jobs, taxes, and financial returns) and other more intangible benefits (in the form of aesthetics, wilderness values, wildlife habitat and clean air and water). It is this central importance of tradeoffs that leads to the need for methods to clarify complex social choices.

2.0 CHARACTERISTICS OF FOREST ALLOCATION DECISIONS[1]

Several factors contribute to the complexity of decisions regarding forest land allocation. Because the purpose of analysis is to gain insight into complexity, there is merit in outlining the nature of these complicating factors.

Multiple Objectives. Forest land allocation decisions inevitably involve a desire to achieve several conflicting objectives at once. The obvious example would be the desire to maintain wilderness values and genetic diversity by preserving old growth forests, and the desire to maintain economic activity in regions dependent on commercial forestry. Moreover, the objectives in such conflicts are often deeply held values as fundamental as religion (Brown, 1982). When values sharply conflict, no alternatives will be universally supported, and insight is needed regarding the relative importance of gains and losses.

Uncertainties. Many sources of uncertainty interact in decisions regarding preservation or harvest. These include uncertainty over: (1) the rates of forest growth, (2) the values of harvest now or in the future, (3) the values associated with preservation, and (4) how local economies would evolve with and without preservation of old growth forests. These factors make evaluation of any alternative course of action difficult and point to the need for analytical procedures to represent uncertainties.

Long Time Horizons. Decisions made over the next few years regarding preservation or harvest of forests will have implications for environmental values and economic activity for many decades. Similarly, the rate of forest harvest in current years has a major effect on the availability of timber for future harvests. This factor points to the need for understanding of the long term implications of these choices.

---

[1] The format (and list of factors) of this section is drawn from a similar discussion in Keeney (1982), where factors contributing to general decision complexity are outlined.

Institutional Framework. For decades, public agencies charged with managing forest lands in British Columbia have largely been concerned with creating opportunities for commercial forest development. Tenure systems have been established and licenses created to encourage the private sector to utilize the forest resources. Similarly, major corporations have made major investments based on expectations that specific forest resources would be available for commercial harvest (Royal Commission on Forest Resources, 1976). In essence, decisions to preserve old growth forests in British Columbia necessarily mean withdrawals of forest land from established forest licenses, which is a difficult process for both the regulators and the forest industry.

Intangibles. Forest land decisions inevitably involve difficult comparisons in which intangible values (such as aesthetics, solitude, spiritual values, or environmental quality) must be balanced against economic returns. In a sense, such comparisons are the essence of what has been termed "sustainable development." The writing on this topic stresses the need for integrating environmental values (which are collective, intangible, and long term) with economic values (which are privately held, measurable in dollars, and short term) (MacNeill, 1989). Yet the sustainable development literature is remarkably silent on how this integration is to be accomplished in practical terms (Pearce, 1988).

Many Interest Groups. Vocal, well organized stakeholder groups have emerged as major influences on forest land allocation decisions. These interest groups are often tied to specific sets of objectives; thus alternatives that favour a particular objective will generally be viewed with favour by a particular interest group. These interest groups essentially operate within the existing political economy framework to try and influence public opinion and play a major role in policy formation.

Related Decisions. Decisions regarding forest land allocation are interrelated in that choices made to preserve or harvest a given area have an influence on the values associated with these same alternatives in nearby areas. In addition, the cumulative effects of many separate decisions must be considered. Finally, the ways in which forests are managed (on a sustained yield basis) mean that decisions regarding harvest, preservation, or the level of investment in silviculture all affect the rate of harvest in a given unit.

Complex Structure. Because decisions to preserve or harvest forest lands are closely related to the rate of forest harvest over time in a given management unit, evaluating the implications of withdrawals from the commercial forest base can be highly complex. The approaches used by foresters to set harvest levels are important in determining the impacts of a given withdrawal. These approaches are, in turn, tied to the rate of forest growth, investment in forest renewal, the nature and size of forest conversion facilities, and many other factors. Models are often employed to analyse harvest levels, which themselves have complexity and embody a number of assumptions about constraints, values, and ways to structure the problem.

Taken together, these factors imply that decisions regarding allocation of forest lands to alternative uses are extraordinarily complex. Since the complexity in these choices cannot be avoided, there is merit in considering analytical approaches that will help provide insight that will lead to better decisions.

Insightful analysis of forest allocation decisions will be particularly valuable for the following reasons (Keeney, 1982):

No Overall Experts. The complex, interdisciplinary structure of these problems means that there are no experts who could use their knowledge and judgement to lead to the right decision. Instead, many different kinds of expertise are required at different times, along with information about value judgements and uncertainties that cannot be provided by any single expert.

High Stakes. When viewed in aggregate, the values at risk in upcoming decisions regarding preservation or harvest of forest lands are enormous. The remaining olf growth forests of the Pacific Northwest and Western Canada are viewed by many as the last large areas on the old growth North American continent. This resource embodies enormous information regarding genetic diversity and ecological complexity; it also provides wildlife habitat, recreation opportunities, and spiritual values that will become extremely important in future decades. The stakes are equally as high on the other side of the question. Withdrawals of forest resources from commercial operations could imperil the economic base of many communities, change a major sector of the economy, and alter the way of life of rural residents.

Need to Justify Decisions. The public nature of these decisions, particularly in British Columbia where the forest base is Crown-owned, implies that choices regarding land allocation need to be justified to stakeholders, decisions makers, and citizens.

In sum, this section has argued that: (1) complexities inherent in forest land allocation decisions mean that well structured analysis is needed to provide insight into these choices, and (b) that there is likely to be a high pay-off to good analysis, in terms of better decisions and wider public support. The next section outlines the elements of an analytical method that addresses these complexities.

3.0 AN ANALYTICAL TOOL FOR ADDRESSING COMPLEXITY IN FOREST ALLOCATION DECISIONS[2]

3.1 Overview

It should be clear that complexity is an inherent part of decisions regarding allocation of forest land to alternative uses. An analytical tool to address these decisions should ideally respond to these complexities in a manner that employs logic and available information to lead to the best possible choice. Moreover, the tool should rest on a conceptual foundation (a normative framework) that is agreed upon as appropriate for the problem if one accepts its underlying assumptions.

Decision analysis is a normative framework for helping to make decisions in which objectives are complex and uncertainties have an important influence.[3] Decision analysis is also a set of applied techniques and methods to provide insight for decision makers. Keeney's definitions, noted in Section 1, suggest that decision analysis encompasses formalized common sense, a philosophy, and a set of procedures, all of which address decision complexity. The intent of this section is to provide a brief overview of the principles and steps of decision analysis. This overview will be a useful background for the subsequent sections in which the four major steps in the decision analysis approach are applied to forest land allocation decisions.

The decision analysis approach focuses on elements that are common to virtually all decision problems. These include: a need to clarify the nature and content of the decision to be made, a desire to achieve several objectives at once with a given decision, a need to compare a number of alternatives which involve different consequences, uncertainty about these consequences, and recognition that the consequences of the alternatives are not valued equally.

---

[2] Sections 3.1 and 3.2 draw heavily on Keeney (1982), which provides an excellent overview of decision analysis for the non-specialist.

[3] The other major normative framework for public decisons is social benefit/cost analysis (SBCA) (Mishan, 1983). SBCA is based on the conceptual framework of welfare economics. In this report, footnotes will be used to contrast the SCBA approach with decision analysis.

Recognizing the extreme complexity in most major decisions, the fundamental approach of decision analysis is to decompose a problem into a number of component parts. Logic, judgement, and available information are used to address specific components of the problem, which can then be reassembled into a framework for analyzing the whole decision. This "decompose-recompose" strategy is essential for addressing interdisciplinary problems (Keeney, 1982).

Decision analysis has its conceptual foundation in a set of axioms that have been stated in von Neumann and Morgenstern (1947), Savage (1954), and elsewhere. These axioms form the basis of statistical decision theory, and are essentially principles for analyzing decisions. Keeney provides the following summary of these principles and their implications:

> The axioms ... imply that the attractiveness of alternatives should depend on (1) the likelihoods of the possible consequences of each alternative, and (2) the preferences of the decision makers for those consequences. The philosophical implications of the axioms are that all decisions require subjective judgements and that the likelihoods of various consequences and their desirability should be separately estimated using probabilities and utilities, respectively. The technical implications of the axioms are that probabilities and utilities can be used to calculate the expected utility of each alternative and that alternatives with higher expected utilities should be preferred. The practical implication of the decision analysis axioms is the provision of a sound basis and general approach for including judgements and values in an analysis of decision alternatives. (Keeney, 1982)

3.2 Methods of Decision Analysis

The methods of decision analysis have evolved over the last 25 years, and have been discussed in detail in books by Raiffa (1968), Keeney (1980), Howard and Mathesen, (1983), von Winterfeldt and Edwards (1986), and others. The intent here is to provide a very brief overview of the basic steps with no discussion. Subsequent sections detail the steps in the context of forest land allocation decisions.

The methods of decision analysis provide a framework to combine statistical theory with the techniques of operations research and management science, as well as professional judgements and public values in a unified framework. With the procedures of decision analysis, models, available data, information from samples and tests, and the knowledge of experts are used to quantify the likelihoods of various consequences of alternatives in terms of probabilities. Utility theory is used to quantify the values of decision makers for these consequences (Keeney, 1982).

For the purposes at hand, the decision analysis approach can be discussed in terms of four generic steps:

(1) Structuring the decision problem.
(2) Assessing possible impacts of each alternative.
(3) Determining preferences (values) of decision makers.
(4) Evaluating and comparing alternatives.

Figure 1, drawn from Keeney (1982), illustrates interdependencies between these steps and indicates where the features of complexity discussed in Section 2 are addressed in the approach. When considering the steps outlined in the figure, two points should be borne in mind. First, iteration among the steps is highly desirable and considered the basis of good decision analysis practice. Both the actions undertaken in each step and how these actions should be accomplished can be affected by the preliminary results from a previous step. Second, decision analysis can sometimes concentrate on some steps almost to the exclusion of others. Partial decision analyses are often appropriate and useful in clarifying particular aspects of a problem. The next four sections of this report are devoted to discussing these four steps in the context of forest land allocation decisions, focusing on old growth forest choices. In each section, an initial discussion reviews the basic procedures of that step. Then a number of key issues associated with accomplishing that step for old growth forest decisions are reviewed. Finally, a simplified example is discussed and carried through the four steps.

Before considering these issues, it will be useful for acknowledge that decision is not new to forestry problems. As discussed below, decision analysis has found application in a number of aspects of forest planning. The novel aspect discussed here is the suggestion that decision analysis is a complete and natural approach to gaining insight into old growth forest preservation questions.

Figure I
Steps in Decision Analysis

Step 1. Structure the problem

- Identify the alternatives
- Specify relevant impact groups
- Determine the objectives
- Define measures of effectiveness (attributes) for each objective

Step 2. Assess the possible consequences of the alternatives

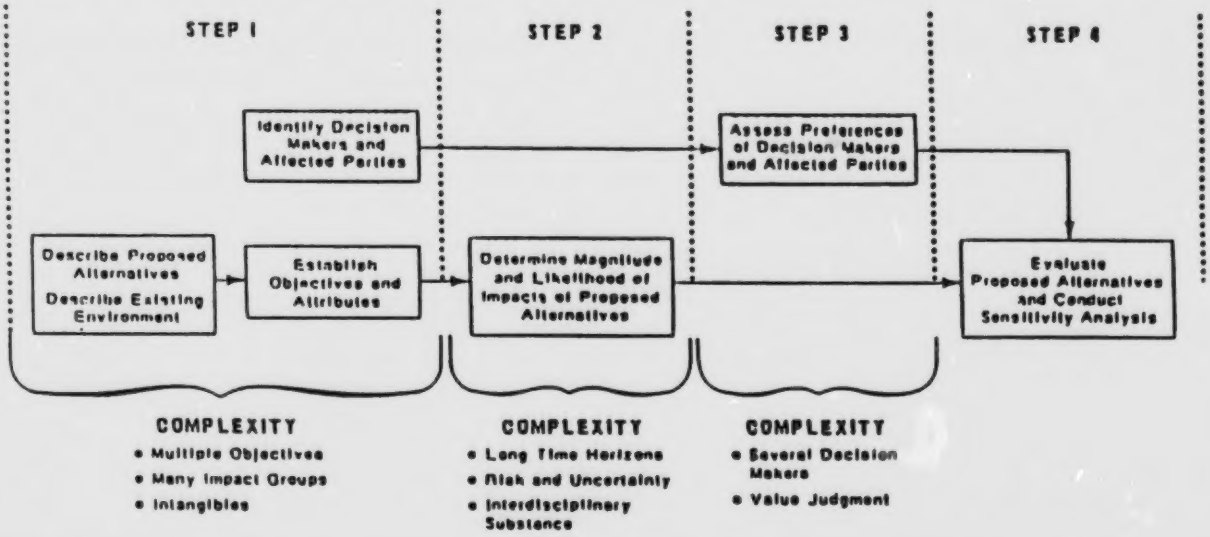
- Quantify consequences in terms of attributes
- Assess judgments of experts
- Collect data and update estimates
- Quantify uncertainty, using probability

Step 3. Determine the preference (value) structure

- Determine the general form of the utility function to quantify the value structure
- Assess the single attribute utility functions
- Assess the value tradeoffs to indicate relative importance of different objectives
- Verify the consistency of the value judgments

Step 4. Evaluate and compare the alternatives

- Integrate the previous information to evaluate alternatives
- Conduct a sensitivity analysis with respect to preferences and consequences
- Reexamine aspects found to be crucial to the decision


STEP 1
STEP 2
STEP 3
STEP 4
Identify Decision Makers and Affected Parties
Assess Preferences of Decision Makers and Affected Parties
Describe Proposed Alternatives
Describe Existing Environment
Establish Objectives and Attributes
Determine Magnitude and Likelihood of Impacts of Proposed Alternatives
Evaluate Proposed Alternatives and Conduct Sensitivity Analysis
COMPLEXITY
• Multiple Objectives
• Many Impact Groups
• Intangibles
COMPLEXITY
• Long Time Horizons
• Risk and Uncertainty
• Interdisciplinary Substance
COMPLEXITY
• Several Decision Makers
• Value Judgment

Source: Keeney (1979)

3.3 Applications of Decision Analysis in Forestry

Decision analysis has been applied with increasing frequency in forestry over the last decade. These applications have been in specific topics, typically involved with choosing forest protection activities (fire and pest management) or forest management regimes (often silvicultural activities). Examples of these areas are discussed below.

Fire Management. A series of studies by Cohan and his co-authors have applied decision analysis to forest fire management. These studies include one concerned with prescribed fire (Cohan et al, 1984), the relationship between silviculture prescriptions and field management practices (Cohan, Haas and Roussopoulos, 1983), and the value of information and fire management (Barrager and Cohan, 1986).

Pest Management. The use of herbicides and pesticided in forestry involves many uncertainties and conflicting objectives, and so is well suited to the decision analysis approach. Examples of the application of decision analysis to pest management include work by Bell (1977), Holling et al (1976), Talerico et al (1978) and Valentine et al (1976).

Silviculture Prescriptions. Approaches for selecting silviculture activities have come under increasing scrutiny in recent years. Brumelle et at (1988) provides a conceptual discussion of a variety of approaches to selecting silviculture options, including the classic decision analytic structure. Pearce, McDaniels and Swoveland (1990) discusses a decision support system that applies decision analysis to silviculture treatment choice; Martell and Fullerton (1986) provides a detailed analysis of a specific investment problem.

4.0 STRUCTURING DECISIONS REGARDING FOREST LAND ALLOCATION

4.1 Overview

If decision making processes founder it is often because of a lack of a clear structure. Structuring a decision can be decomposed into three parts: defining the decision to be made, specifying objectives, and generating alternatives. When attempting to structure a controversial decision such as preservation or harvest of a specific old growth forest, completing these steps can be a daunting task. This section provides an overview of generic issues associated with structuring such decisions; the intent is to suggest valuable ways to approach such problems in general terms, not to analyze a specific question. Nevertheless, a simple example is developed to illustrate these points, which will be enlarged in subsequent sections.

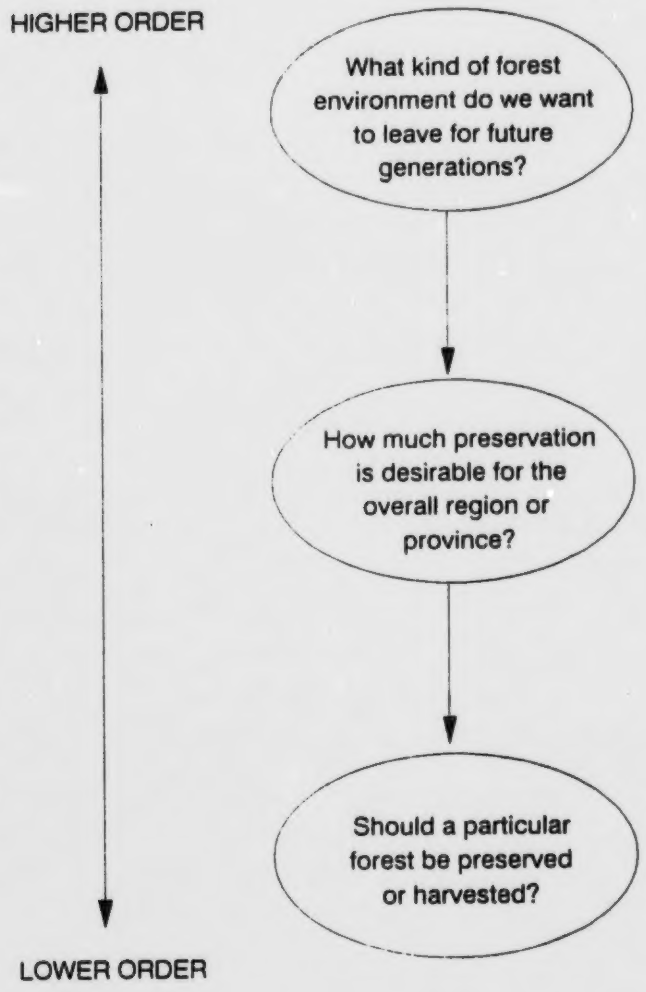
4.2 Defining the Decision To Be Made

When controversy arises over preservation of a specific forest, the decision to be made may seem obvious: either the area is harvested or not. In fact, decisions of this nature are interrelated and need to be considered carefully. Consider a situation where a decision maker is confronted with many separate preservation conflicts within a large region. Suppose that on the basis of political processes, analysis, or other means, the decision maker concludes that the appropriate course of action is to commit each separate area to commercial harvest. Yet, after all these decisions have been made, the decision maker discovers that she is left with far less preserved old growth forest than seems desirable in aggregate. The problem is one of judging the cumulative impacts of a number of separate decisions. An effective way to deal with such a problem is by understanding the relationships between these decisions and the implications for more fundamental questions.

Figure 2 presents a hierarchy of decisions regarding questions of whether to preserve or harvest old growth forest areas. The lowest level decision, and the one typically articulated in such conflicts, would be: "Should a particular forest be committed to preservation or harvest?" Influencing the answer to that question is a higher order question: "How much overall preservation of old growth forest is desirable?" A still higher order question is: "What sort of forest environment do we want to leave to

FIGURE 2

HIERARCHY OF DECISIONS REGARDING FOREST PRESERVATION


HIGHER ORDER
What kind of forest environment do we want to leave for future generations?
How much preservation is desirable for the overall region or province?
Should a particular forest be preserved or harvested?
LOWER ORDER

future generations?" To gain insight into the lower level questions, it is important to consider the higher order question.

This shift to more fundamental questions and a region-wide, or province-wide, frame of reference for old growth forest preservation decisions can be seen in a number of the organizational processes underway to address these issues. In British Columbia, a task force on old growth forests has been established; part of its implicit responsibilities are to address underlying questions and the problem of the overall level of preservation. Similar efforts are underway in the Pacific northwest states.

4.3 Structuring Objectives

Specifying objectives for a decision is a crucial aspect of any analysis, and one that is often overlooked or only addressed implicitly. A useful starting point for specifying objectives is to ask "What is important in this problem?" Another good approach is to create a list of the possible consequences of the alternatives that are considered important. These consequences can then be aggregated into a set of general concerns. Drawing on all this information, a hierarchy of objectives can be developed, with broad objectives pertaining to general concerns at the top of the hierarchy and more detailed objectives further down. For each of the lowest level objectives in the hierarchy, it is necessary to identify attributes, or performance measures, to evaluate the degree to which the objective is achieved. Often, this is an easy task; an obvious attribute for the objective "maximize profits" would be in dollars. Defining attributes for objectives like "minimize degradation of aesthetic features" is more difficult. Keeney (1986) provides an extensive discussion of the process of structuring objectives for problems of public interest, and gives examples of how attributes can be defined both qualitatively and quantitatively.[4]

A key to structuring controversial public decisions is to clarify objectives of various stakeholder groups. This step is important for a number of reasons: structuring public debate, identifying areas of agreement and disagreement, and fostering negotiation. A useful procedure for clarifying objectives is to develop objective hierarchies for key stakeholder groups. That procedure was undertaken in a brief case study undertaken for this project.

---

[4] Its multiple objective structure is perhaps the fundamental feature that differentiates decision analysis from SCBA. In SCBA, the objective for social choice is assumed to be economic efficiency. All benefits and costs are valued in economic terms (in dollars) to represent welfare changes. Thus, all aspects of a decision, including those not well measured in dollar terms (such as the value of intangibles)must be evaluated on that basis, in order to be included in the analysis.

For the case study, four individuals with interests in old growth forest preservation decisions in British Columbia were interviewed. These individuals were selected to represent various stakeholder groups; they included a representative of the forest industry (Group 1), a person knowledgeable about key issues important to the science community (Group 2), and representatives from two environmental interest groups, one concerned with wildlife (Group 3) and one concerned with wilderness issues (Group 4). The individuals were contacted by telephone and asked if they would participate in an interview process intended to clarify and document the interests of their groups regarding forest preservation issues. All readily agreed to participate. A set of briefing notes was prepared before meeting any of these interest group representatives, to ensure that each group received the same basic information about the process. The briefing notes are included as Appendix A of this report.

Separate interviews were conducted with each of the four interest group representatives. The interviews attempted to clarify the objectives that the group judged to be important for decisions about old growth forest preservation or harvest in British Columbia. The basic question addressed in the interviews was, "What objectives do you think are relevant for old growth forest decisions generally in the province?" There was no attempt to tie the interviews to a specific land use conflict.

Various techniques were employed to spur thinking: participants were asked to discuss the factors they think are important and the implications (consequences) that particularly concern them. Generally, the interviews proceeded smoothly and participants had no difficulty in voicing their views. At certain points, additional objectives were suggested and participants were asked to indicate whether they believed were relevant for the question. Care was taken to distinguish ends from means, and to identify the relationships between objectives. After the interviews were completed, tape recordings and notes of the interviews were reviewed, and objectives of individual (representing one group) were structured into a separate hierarchy.

Comparison betweeen the hierarchies indicated remarkable similarities between the objectives of the groups. For example, all groups agreed that maintaining genetic diversity and building scientific information are important objectives in old growth forest preservation decisions. Providing opportunities for recreation, solitude, and spiritual purposes, and maintaining regional employment, were also mentioned as important by each group. Nevertheless, there are notable differences between the hierarchies. In general, a more refined representation of objectives was articulated for issues important to the interest of a particular group. For example, representatives of the group concerned with wildlife were able to articulate in more detail aspects of maintaining genetic diversity they felt were important. Similarly, the science group representative discussed the question of contribution to global change in detail. The representative of the forest industry had a more refined representation of objectives regarding the impacts on communities.

Figure 3 provides a combined hierarchy of objectives that incorporates the key objectives mentioned by each group. It is important to stress that the objectives in this combined hierarchy are not purported to represent the complete spectrum of viewpoints regarding old growth forest preservation decisions. On the contrary, participants pointed out during interviews that a number of additional interest groups should be interviewed, including: native bands, members of rural communities, and governments. Another relevant stakeholder group might be young people, in that future generations will bear the consequences of preservation decisions. Nevertheless, the results reported here provide useful insights regarding the objectives of groups associated with old growth forest preservation. There are similarities in terms of stated objectives, with more clarity being articulated for objectives with which the groups are most familiar. Two further steps not addressed in this exercise would include definition of attributes (or performance measures) associated with the various objectives and judgements regarding the relative importance of the various objectives, as discussed in Section 6.

These preliminary findings suggest there may be merit in extending this initial case study. Some of the steps to be considered would include: extending the number of

FIGURE 3

HIERARCHY OF OBJECTIVES REGARDING FOREST PRESERVATION DECISIONS: COMBINED HIERARCHY FOR FOUR STAKEHOLDER GROUPS

- 1 Maximize Scientific Opportunity
  - 1.1 For Forest Management Research
    - 1.1.1 Evaluation
    - 1.1.2 Improvement
  - 1.2 For Ecological Research
    - 1.2.1 Resilience
    - 1.2.2 Stability
  - 1.3 For Utilitarian Research
    - 1.3.1 Genetic Information
    - 1.3.2 Human Adaptation

- 2 Maximize Environmental Diversity
  - 2.1 Species Diversity
  - 2.2 Ecosystems
    - 2.2.1 Number
    - 2.2.2 Complexity
      - 2.2.2.1 Size
      - 2.2.2.2 Elements

- 3 Minimize Global Climate Change
  - 3.1 Carbon Stores
    - 3.1.1 In Harvest
    - 3.1.2 In Preserved Stands
  - 3.2 Carbon Conversion
    - 3.2.1 Young Stands
    - 3.2.2 Old Stands

- 4 Maximize Global Resource Availability
  - 4.1 Single Use Areas
  - 4.2 Flow of Essential Products

- 5 Maximize Opportunity for Forest Enjoyment
  - 5.1 In Small Areas
    - 5.1.1 Aesthetic
    - 5.1.2 Recreational
    - 5.1.3 Cultural
  - 5.2 In Large Areas
    - 5.2.1 Aesthetic
    - 5.2.2 Recreational
    - 5.2.3 Cultural

- 6 Maximize Sustainable Economic Structure
  - 6.1 Long Term Total Employment
  - 6.2 Long Term Business Activity
  - 6.3 Long Term Provincial Revenues

... continued

- 7 Minimize Environmental Impacts
  - 7.1 Short Term
    - 7.1.1 Flora
    - 7.1.2 Fauna
  - 7.2 Long Term
    - 7.2.1 Flora
    - 7.2.2 Fauna

- 8 Minimize Adverse Impacts on Communities
  - 8.1 Employment
    - 8.1.1 Direct
    - 8.1.2 Indirect
    - 8.1.3 Diversity
  - 8.2 Social
    - 8.2.1 Family Cohesion
    - 8.2.2 Social Illness
  - 8.3 Municipal
    - 8.3.1 Revenues
    - 8.3.2 Infrastructures
  - 8.4 Environmental
    - 8.4.1 Aesthetics
    - 8.4.2 Recreation

- 9 Minimize Adverse Effects on Future Generations
  - 9.1 Environmental Stewardship
  - 9.2 Economic Stewardship

---

interest groups involved, refining the objectives for each group, creating an overall hierarchy, defining attributes for the objectives, and elicitation of values for various groups.

4.4 Constructing Alternatives

The generic alternatives considered in a preservation or harvest decision typically include all preservation, all harvest, or some combination (usually a 50/50 split). Yet, these alternatives only vary the extent of the harvest and all are likely to be starkly unattractive to some groups. By considering the objectives outlined in the previous section, it may be possible to construct generic alternatives that vary other aspects of the problem and that are more attractive to all parties. Examples could include varying aspects of how harvests are conducted, or ways in which changes in harvest levels are phased in over time. Section 5 discusses the development of innovative alternatives in more detail as part of assessing the consequences of alternatives.

4.5 An Example Analysis

An example analysis will be useful to illustrate the concepts discussed here. The example will be further developed in subsequent sections to clarify how the steps fit together. Suppose a controversy has arisen over whether to preserve or harvest a particular valley containing old growth coniferous forest, which comprises part of a forest management unit in British Columbia. The area in question contains roughly 2 percent of the total standing forest inventory of the forest management unit. The valley contains stands that are considered to be highly aesthetic, ecologically important, and highly values by recreationists. A number of interest groups have a stake in this controversy, including the forest industry, the provincial government, the communities that could be affected by withdrawals, environmental preservation groups, scientists, and the public at large, because of its role as the resource owner.

Suppose that the focus of the decision is, in this case, whether the preserve the particular valley, even though it is recognized that higher order questions (such as the appropriate level of overall preservation) should influence this decision. Also suppose that an objective structuring exercise has been completed along the lines just outlined. Finally, suppose the combined objective hierarchy in Figure 3 represents the range of objectives that should ideally be considered in the analysis, given the factors judged important by the affected groups.

Suppose the public agency charged with managing these forest lands is considering three options:

(1) Withdraw the valley from the forest management unit and create a park (Alternative A). This withdrawal would create an immediate reduction in the harvest of the management unit.

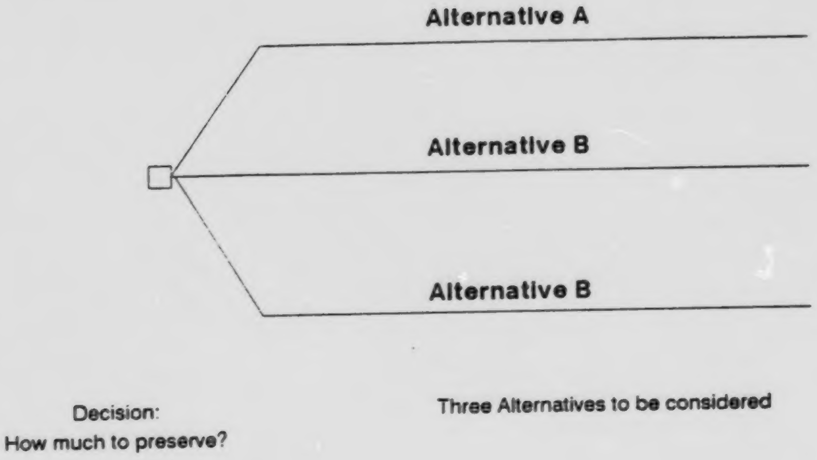
(2) Allow the valley to remain within the forest management unit for commercial harvest, but slightly alter the pattern of harvest and preserve a few groves of trees that could be viewed as representative of the ecosystem (Alternative B).

(3) Undertake commercial forestry in half the valley and preserve the remaining half (Alternative C).

Figure 4 outlines a decision tree that represents the structure of this simple example. Subsequent sections will build on this structure. In the figure, the square is a "decision node", indicating a decision to be made. The three alternatives (A, B, and C) are shown as paths that could be followed, or options under consideration in the decision.

FIGURE 4

SIMPLE DECISION TREE FOR THE EXAMPLE ANALYSIS


Alternative A
Alternative B
Alternative B
Decision:
How much to preserve?
Three Alternatives to be considered

5.0 ASSESSING CONSEQUENCES OF FOREST LAND USE ALTERNATIVES

5.1 Overview

Once the structure has been established for a particular decision, the next task is to determine how various alternatives could be expected to perform in terms of the relevant objectives. Decision analysis begins with the recognition that alternatives may have a variety of consequences that are important to decision makers (as just outlined) and also that the consequences cannot be predicted with certainty. Recognition of uncertainty calls for the use of probability to represent uncertainties in a formal manner, which is a crucial step of decision analysis. The task is to determine a probability distribution function $p_j(x)$ over the set of attributes for each alternative.

Information regarding probability can be drawn from many sources. Formal models that draw from the traditional methodologies of operations research, systems analysis, and elsewhere can be constructed when the problem is sufficiently complex. Such models could have several components, each of which could draw on knowledge associated with a separate discipline or aspect of the problem. Experts in each area could then provide information on a specific part of the problem, which can then be aggregated with simulation or analytically. Morgan and Henrion (1990) provide an extensive discussion of the treatment of uncertainty in policy and risk problems.

Two basic sources of probabilistic information about the effects of alternatives are analysis of existing data and use of expert judgements. Quantitative assessment of professional judgements in terms of probability is a unique aspect of decision analysis. Methods for quantifying probabilities have been discussed by a number of authors including Spetzler and Stael von Holstein (1975), Morgan and Henrion (1990), and others. An interview approach is adopted which a probability assessor uses logic and a formal structure to constructivly elicit judgements from a technological expert regarding the likelihood of various outcomes. Errors can easily occur in such judgement processes; Kahneman, Slovic and Tversky (1982) provide an extensive discussion of the heuristics and biases that arise in judgements about uncertainties. Nevertheless, experiments suggest that professionals with training and frequent feedback can become relatively well-calibrated (accurate) probability assessors.

5.2 Generic Issue in Analysis of Forest Management Options

To illustrate the complexities involved in analysis of forestry allocation decisions, consider the example outlined in the previous section. How should the alternatives in Figure 4 be compared and evaluated? Three basic points are useful in choosing how to clarify the merits of these alternatives:

(1) Analysis should be structured to provide information regarding the complete set of objectives considered important in a given problem. For the example of Figure 4, the objective hierarchies discussed in the previous section are a useful starting point. Too often, analysis focuses only one objective, or even a corner of the problem not directly related to the objectives.

(2) To conduct analysis that indicates how the alternatives perform, attributes (performance measures) must be specified for each objective. Suppose that in the example of Figure 4 we have decided to simplify the analysis to two objectives: maximizing the stability of regional employment and (for want of a better term) maximizing wilderness preservation. This simplification is adopted to allow clarity in the discussion of the example. Attributes must be defined for these objectives, which in this example could be: the sum of the absolute value of annual change in total regional employment in person years over the relevant period (zero would be the best possible performance level for this attribute); and the number of hectares of forest more than five kilometres from a road that have never been commercially harvested. Analysis would then be conducted to predict the levels of these attributes that are associated with the alternatives. Thus, the choice of objectives influences the relevant attributes, which in turn shape the analysis to be conducted.

(3) Complexities within the problem mean that it is impossible to estimate the consequences of the alternatives with certainty, or in some cases even have a complete picture of possible consequences. Thus, attention must be paid to uncertainties implicit in the alternatives.

Beyond these overall points, four specific issues are key to understanding the consequences of alternatives in forestry preservation decisions:

(1) What is the "default" case? What would happen in terms of the key objectives (regional employment and wilderness preservation) if the decision had not arisen?

(2) What possibilities could be created as a result of different alternatives? How might the regional economy evolve in response to changes in the forest harvest base?

(3) How do analytical models and other approaches used by foresters to set harvest levels constrain the alternatives and influence the consequences? How might new alternatives be created that perform better in terms of the objectives?

(4) How should uncertainties be explicitly considered in the analysis?

These questions are addressed below.

5.3 The Default Case

The default case (or base case) refers to the basis of comparison for an impact assessment. Typically, impact assessment would involve an analysis based on a comparison between the situation with a particular policy or project, and without a policy or project. Thus, in assessing the socioeconomic consequences of, say, a new steel mill, forecasts are required of how a regional economy would evolve both with and without the new steel mill. The role of the "without" case is to provide a realistic basis for comparison. In the absence of a "without" case, comparisons would typically be made with the status quo, which would often be misleading because of changes in the key variables that are likely to occur in any case.

When considering the example analysis of Figure 4, two factors make consideration of the default case particularly important:

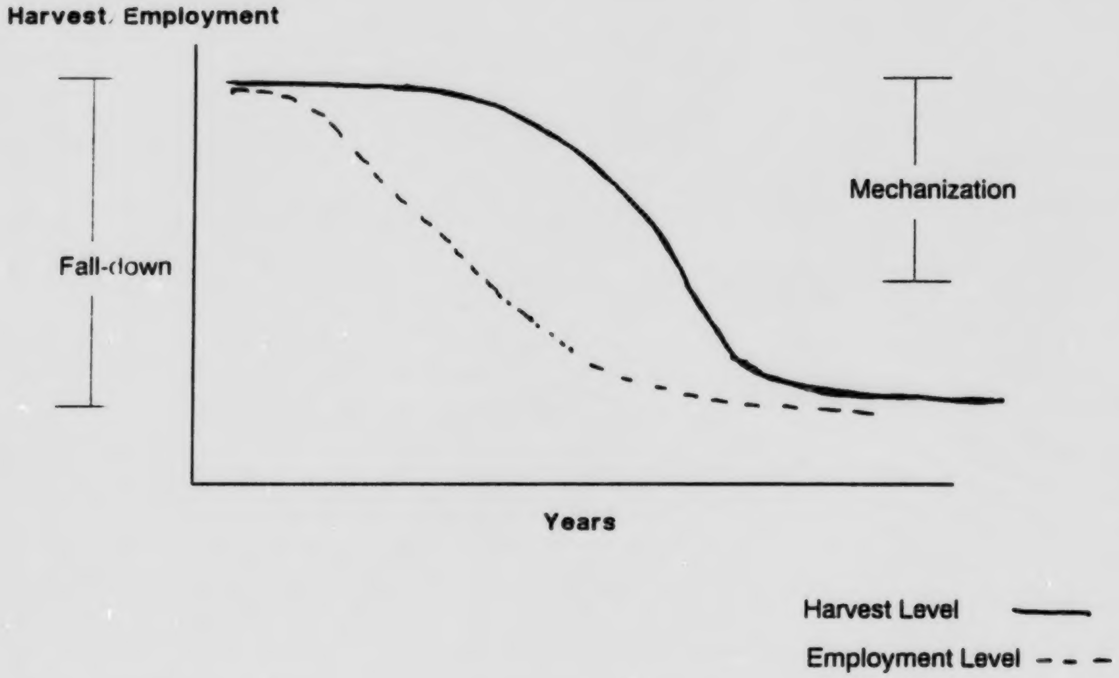
(1) The level of employment in many forestry communities has dropped within the last fifteen years because of a steady trend towards mechanization in both harvesting and processing. Thus, the employment base of the forest industry has declined and will likely continue to decline, even without withdrawals.

(2) As forest management units make the transition from old growth to second growth harvests, there is likely to be a long term "fall down" of annual harvest in each management unit (Royal Commission on Forest Resources, 1976). The easiest way to understand the fall down effect is to realize that at maturity a second growth forest will likely contain considerably less volume of harvestable forest per hectare than an old growth forest, because the second growth trees are only allowed to grow to perhaps 70 or 80 years. Although there is a difference of scientific opinion regarding the likelihood and size of the fall down in second growth harvests, consensus seems to be that harvests are likely to fall over time. Moreover, there seems to be strong evidence that fall downs are expected in economic terms, if not biological terms. There may be more low quality wood of marginal value, meaning the size of economically viable harvest could decline (Thompson et al, 1990).

Figure 5 combines these two considerations in one graph. It indicates a typical pattern of fall down in forest harvests over time, as well as possible employment changes in a hypothetical management unit over time. While these curves are not intended to represent the situation in any specific management unit, they illustrate a typical pattern. The key point is that both reductions in harvests and reductions of employment are possible (even likely) in most forest management units, regardless of whether withdrawals occur for preservation purposes. Therefore, any analysis of

FIGURE 5

HYPOTHETICAL PATTERNS OF EMPLOYMENT AND HARVEST IN A FOREST MANAGEMENT UNIT



potential withdrawals must be superimposed upon a default case that reflect the expected course of events without withdrawals. The result may be that reductions in employment due to withdrawals are minor in comparison to employment changes associated with mechanization and the fall down effect. We will return to this topic subsequently.

5.4 What Possibilities May Be Created?

A striking feature of the public debate regarding preservation or harvest decisions is the widespread confusion (and entrenched positions) regarding the possible economic consequences of withdrawals. Stakeholder groups generally recognize that employment in the forest industry could be adversely affected, but possible changes in employment patterns due to enhancement of other industries is not readily considered. An obvious example is the potential for of a service-based economy in regions affected by withdrawals, which could involve services to tourists interested in adventure and wilderness activities, or even a service economy based on information technologies. The other possibility would be new, enhanced forest sector employment due to closer utilization, remanufacturing of sawn lumber, and intensive management.

A useful approach when grappling with possible shifts in the status quo that are difficult to envisage is to develop scenarios. Scenarios can be described as evocative, simplified representations of the future decision environment. Scenarios for forestry allocation decisions could be structured to illustrate possibilities regarding fundamental shifts in values and activities and the implications for regional economies. When developing scenarios, it is important to distinguish between the possibilities and preferences. For example, scenarios can be useful in informing decision makers about new patterns that could evolve after a change in resource management policy. These scenarios should not be interpreted as an argument that these new patterns are desirable. Possibilities refers to situations that could occur, while preferences refers to judgements as to whether the possibilities are desirable. For example, workers in the forest industry who could be disadvantaged by withdrawals for preservation purposes are not likely to be persuaded to support withdrawals through arguments about growth in the tourist sector. The reason is that the forest workers could stand to be disadvantaged, while other groups may benefit from new opportunities created. The intent of scenarios is to inform, not to persuade.

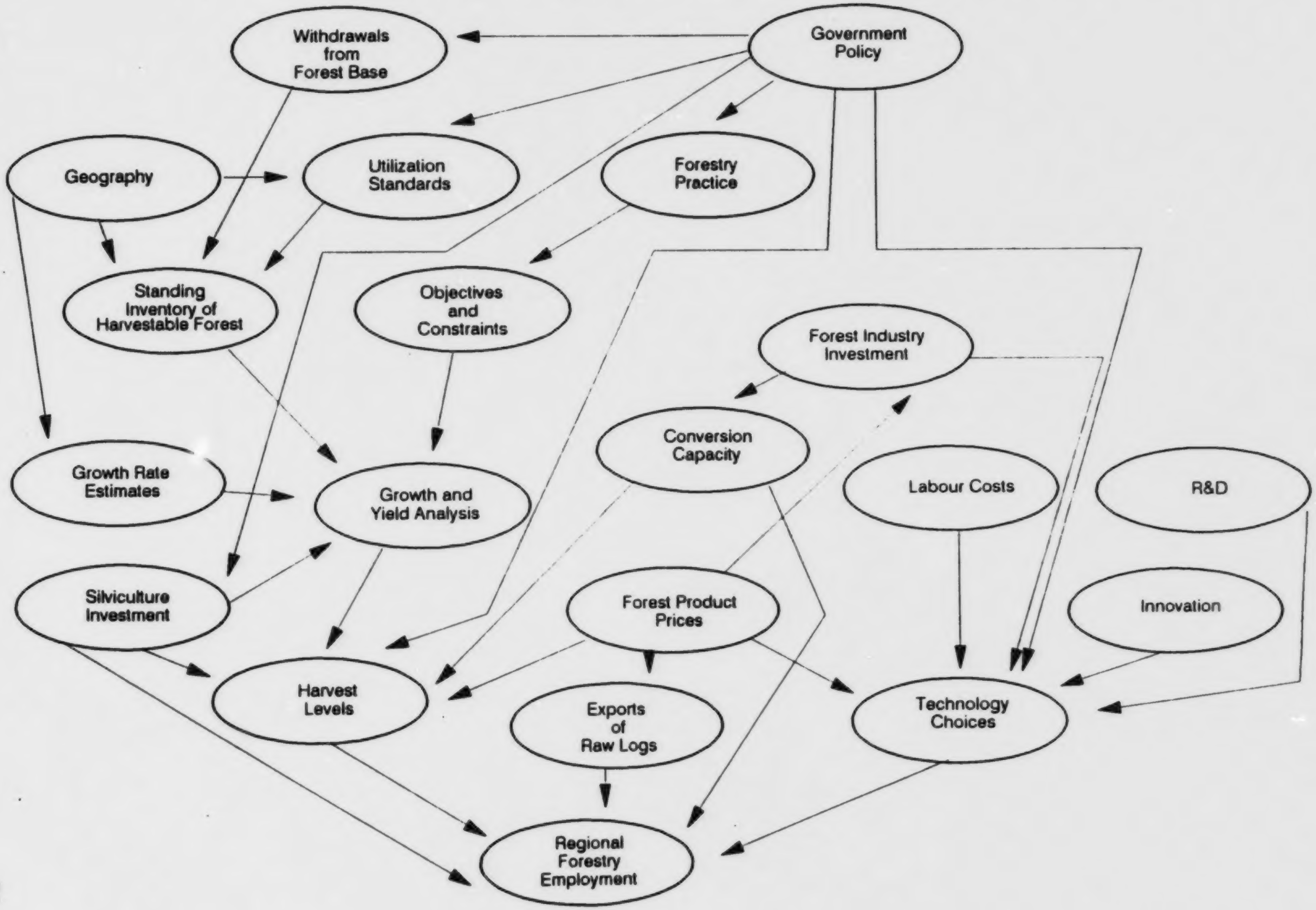
5.5 The Implications of Approaches to Setting Harvests

The example introduced in Figure 4 involves a possible withdrawal of 2 percent of the forest inventory for preservation purposes. What would be the implications of such a withdrawal in terms of annual harvest? What in turn would the harvest changes mean in terms of changes in employment patterns? At one extreme a 2 percent reduction in inventory could simply mean that starting immediately the amount of harvest that occurs on every day of operations from now into the future is reduced by 2 percent. At another extreme, it could mean that harvest levels are maintained at their current levels for the next 49 years, and then in the 50th year, no harvest occurs at all. Both patterns would result in the same amount of timber being cut over a 50-year period. Between these two extremes are countless alternatives involving different profiles of changes in harvest over time, that have strikingly different implications for employment patterns.

This example illustrates that the ways in which harvest levels are set by forest managers could have a dramatic effect on employment. Decisions on harvest regimes are typically based at least in part on analysis (linear programming or simulation) that estimates how a given inventory of trees, expected to grow at particular rates, could be harvested over time to yield a reasonably even flow of harvest. Underlying these modelling approaches are specific objectives for forest management, which could be described as a desire to maximize the long term sustainable yield from the forest, within specific constraints. In a linear programming approach to yield analysis, these objectives and constraints are cast in terms of an objective function for the analysis.

The point is that the choice of approaches to set harvest levels is a major determinant of the ultimate impacts of a withdrawal. Figure 6 illustrates this point. It shows the relationship between inventories, models, technology, and other variables that influence the level of regional forest employment. When discussion focuses on withdrawals from inventories, it ignores all the other factors that are part of the

FIGURE 6
FACTORS INFLUENCING FOREST HARVEST AND EMPLOYMENT LEVELS


Withdrawals from Forest Base
Government Policy
Geography
Utilization Standards
Forestry Practice
Standing Inventory of Harvestable Forest
Objectives and Constraints
Forest Industry Investment
Conversion Capacity
Growth Rate Estimates
Growth and Yield Analysis
Labour Costs
R&D
Silviculture Investment
Forest Product Prices
Innovation
Harvest Levels
Exports of Raw Logs
Technology Choices
Regional Forestry Employment

process. In particular, the objectives and constraints built into models may be a major influence on employment effects of withdrawals.

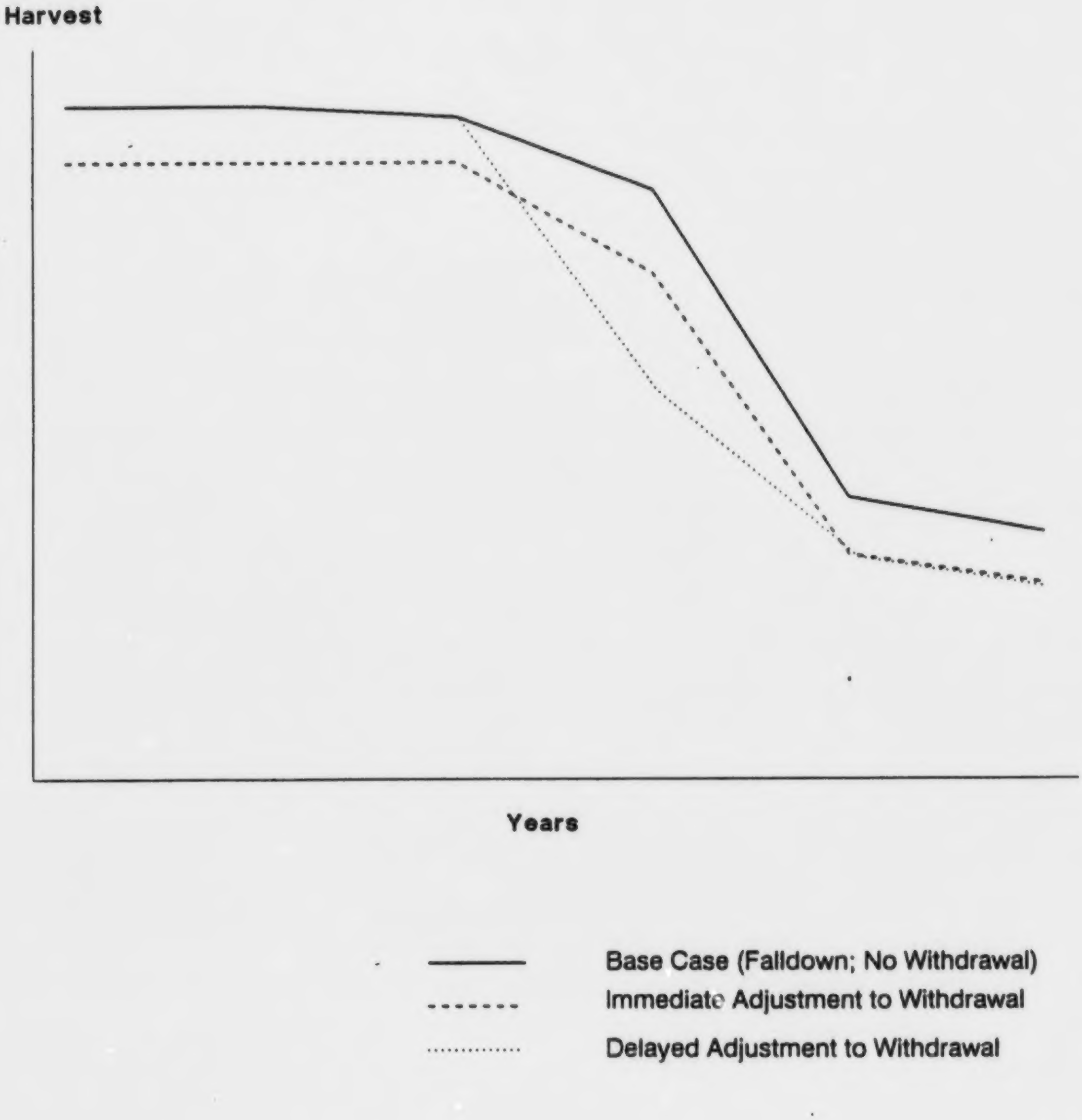
Another key point is that these modelling approaches may inadvertently limit the range of alternatives that are considered when conflicts over preservation or harvest arise. The earlier discussion indicated that there are a variety of ways in which a withdrawal could be accommodated in terms of harvest over time. Yet the typical approach (implicit in how forest resources are managed) would be that a withdrawal would translate into an immediate reduction in harvest. It would seem that maintaining harvests at current levels during a period of adjustment, and then implementing gradual reductions in harvest lestls would be an attractive alternative, and a means of making withdrawals more acceptable to those affected. Maintaining harvests at current levels during a period of adjustment could provide more certainty to communities and corporations, and also provide near term financial returns that are more valuable to firms than returns from harvests decades in the future.

To conclude this discussion, let us return to the hypothetical example that introduces this section and link the concept of maintaining harvest levels during adjustment periods with the earlier discussion regarding fall down effects and the default case. Suppose the solid line in Figure 7 indicates the expected fall down in harvest anticipated in this management unit, regardless of whether a withdrawal occurs. Then the two dotted lines indicate two patterns of adjustment to the withdrawal of old growth. One line shows an immediate decline in harvest that persists over the planning period. The second pattern shows no initial reduction, then a reduction at the same rate as the default case, but a few months (or years) sooner. The difference between the default case and the latter adjustment scenario is simply that the fall down in slightly advanced, and the long term second growth harvest is slightly lower. Of source, the other difference is that part of the old growth forest is preserved under the withdrawal case.

The adjustment pattern just discussed is an example of how creative alternatives could possibly be devised that serve the interests of many stakeholders. The employment indications of the delayed reduction harvest pattern are simply that the inevitable decline in harvest due to the fall down is advanced slightly. Of course, the

FIGURE 7

ALTERNATIVE PATTERNS OF HARVEST
AFTER A WITHDRAWAL



examples in Figure 7 are not based on data or actual yield analysis runs. This is an area where further case studies would be informative.

5.6 How Should Uncertainties Be Considered?

Uncertainties arise over many aspects of decisions regarding preservation or harvest of old growth forests. For convenience, these uncertainties can be grouped into three categories: physical aspects of the forest base; the nature of regional economies under various harvest regimes; and future values, particularly those associated with environmental resources.

Uncertainties arise over two physical aspects of the forest base in a management unit, the current inventory of forest resources, and the rate at which forest resources will grow over time. In British Columbia, the resource base within management units is sufficiently complex that often the available data regarding the status of the forest resource is highly uncertain. Similarly, the data used to estimate equations upon which forest growth models are constructed also is quite uncertain. Uncertainties in inventories and growth models could have a major effect on the choice of harvest rate in a management unit, and thus on employment regimes. Surprisingly, foresters have only addressed analysis of uncertainties in management problems within recent years. One of the reasons is that the optimization techniques employed for yield analysis are not well suited to accommodating uncertainties. Hoganson and Rose (1987) illustrate how linear programming approaches to timber management can be used in conjunction with scenarios to represent uncertainty over one or two key variables.

Uncertainties in the future potential for regional economies was a point discussed earlier in this section. A key problem for these variables is to identify possibilities and then develop useful means of achieving these possibilities, if they are judged to be desirable.

Finally, uncertainties over values may be the most difficult to handle analytically. One reason is the dramatic shift in North American values that seems to have occurred regarding environmental resources in the last five years. A second complicating factor is the changes in the environmental quality occurring on a world wide basis, which make the wilderness resources still available in British Columbia increasingly more valuable in global terms. Yet, analytical means of determining the value for factors such as genetic diversity are not well developed. Similar problems arise in attempting to forecast the values associated with commercial harvest. For example, what might be the net returns associated with harvesting forest resources in a given area twenty years from now, rather than harvesting that timber today? These estimates involve uncertainties over future supply of forest resources, which are complicated by the possibility of new global sources of supply.

Judgement is invariably required to link appropriate analytical approaches to specific sources of uncertainty. The following points offer some suggestions as to how uncertainties could be treated analytically:

(1) Uncertainties over growth rates and inventories could be handled analytically by analysis of various scenarios, which can then be weighted to provide distributions over outcomes. If, say, five scenarios were judged to be appropriate regarding inventory levels, and five were adequate to convey uncertainties over growth rates, and the scenarios for the two variables were judged to be independent, 25 (5x5) overall scenarios would adequately represent the uncertainties. These could be used to construct an overall distribution regarding possible harvests over time, holding policies regarding how growth rates are set constant.

(2) Uncertainties over future economic possibilities are less tractable in analytical terms. Here, the best approach may be to identify two or three scenarios that convey the range of possibilities to decision makers and factors that will influence which of the possibilities eventually occurs. If desired, the scenarios could be assigned probabilities with subjective assessments.

(3) Uncertainties over values are best handled through a bounding approach. Possible extremes in values could be used as a basis for showing the range of possible outcomes. This bounding approach can be used to identify which value uncertainties are most important to the results, and thus focus efforts to refine information about future values.

5.7 The Example Analysis Revisited

Let us return to the example outlined in Figure 4 and incorporate some of the concepts just reviewed. Figure 8 presents an enriched representation of the decision under consideration. We see that a new alternative (D) has been added which represents a compromise regarding the ways in which forest withdrawals will be incorporated into the annual harvest for the management unit. Instead of the reductions in regional employment occurring immediately, they are delayed a few years and effectively move up the period of the fall down, as outlined in Figure 7. Thus, the new alternative is an example of how understanding the objectives of the key stakeholder groups can be useful in restructuring existing alternatives to make them more attractive.

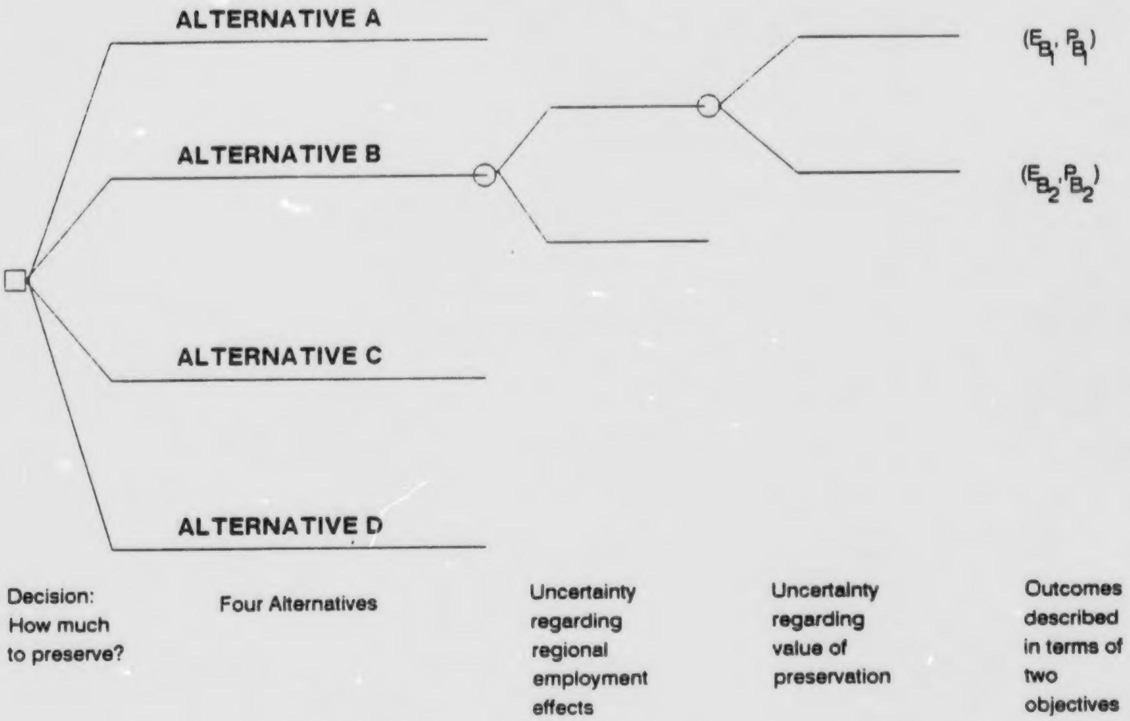
A number of other considerations have been added to the figure that illustrate some of the key issues in analysis of the decision. These include:

(1) Uncertainties regarding effects on regional employment are specifically represented (a circle in a decision tree represents a chance variable, or an uncertainty, while a square represents a decision to be made). Two scenarios are developed to represent the range of outcomes for each alternative. The scenarios represent uncertainties over the implications for regional forestry employment for that alternative. In the interest of simplicity, we will not describe the scenarios here. Probabilities must be attached to the scenarios under each alternative to represent possibilities regarding the future. Note that not all the chance nodes for the alternatives are shown in Figure 8, to make the figure clearer.

(2) Uncertainties are also represented regarding the future values associated with preservation of the area. These values are uncertain because of the difficulty of judging how important preserved forests will be in the future, as well as how valuable different levels of preservation would be in this valley. Again, these uncertainties are represented with a circle and two scenarios.

FIGURE 8

EXPANDED DECISION TREE FOR EXAMPLE ANALYSIS


ALTERNATIVE A
ALTERNATIVE B
ALTERNATIVE C
ALTERNATIVE D
(E_{B_1}, P_{B_1})
(E_{B_2}, P_{B_2})
Decision: How much to preserve?
Four Alternatives
Uncertainty regarding regional employment effects
Uncertainty regarding value of preservation
Outcomes described in terms of two objectives

(3) At the endnotes of the decision tree, we can represent the outcomes in terms of the two objectives of interest. E represents the employment objective, while P represents the preservation objective. Thus, E_{B_1} represents the performance of alternative B (given Scenario 1) in terms of objective E.

We now have a representation of the decision problem that includes four alternatives, as well as explicit attention to uncertainties over the two key objectives and representation of the results of a number of scenarios. Subsequent sections address how we start to evaluate and make choices across these consequences.

6.0 DETERMINING PREFERENCES FOR FOREST LAND USE DECISIONS

6.1 Overview

In any decision context, once the consequences of alternatives have been estimated, the task at hand is for decision makers to judge which consequences they prefer over others. Two questions frequently arise in this context. One question is "How much should be foregone in terms of one objective to achieve a specified improvement in another objective?" This question involves value tradeoffs. The second is, "Are the potential benefits of having things go right worth the risk if things go wrong?" This question involves risk attitudes (Keeney, 1982). These questions are particularly complicated because there are no right or wrong answers. Reasonable people differ regarding their values and their attitudes towards risk.

In essence, these questions point to the need for an overall objective function, which aggregates across the the individual objectives and incorporates attitudes towards risk. In decision analysis, an objective function is usually referred to as a utility function, symbolically written u. Then $u(x)$, the utility of the consequence x, indicates the desirability of x relative to all other consequences. Development of a utility function essentially involves creating a model of values with which to evaluate alternatives. Decision analysis is unique among analytical tools in that it models values explicitly by addressing multiple objectives and attitudes towards risk within a decision problem.

Two fundamentally different kinds of approaches could be adopted to build a utility function: expressed preference and revealed preference. The expressed preference approach involves a structured discussion between decision analyst and decision makers to constructively elicit value judgements. Systematic approaches are employed to elicit relevant information about value tradeoffs, equity concerns, and risk attitudes.

One criticism of value elicitation methods is that people's judgements may be inherently unstable, or labile, and prone to influence by the process. The implication is that answers "off the top of someone's head" may not be a true indication of preferences. Fischhoff, Slovic and Lichtenstein (1980) argue that values are most often labile when questions are unfamiliar and people do not have well-formed opinions. In such situations the analyst, and the question structure, can strongly influence the results. Fischer suggests that this is not necessarily a drawback. When preferences are ill-formed, asking probing questions may produce clarity rather than induce confusion. In that case, the elicitation process is a constructive one, in which the analyst is an active partner, helping to build understanding and clarity (Fischer, 1979).

The revealed preference approach to building a utility model could involve either conjoint measurement or interactive procedures. Conjoint measurement involves asking decision makers to order a series of alternatives, each of which involves different levels of performance regarding a set of objectives. Then statistical analysis is used to estimate an individual model of preferences based on the order of responses and differences between alternatives. Brumelle et al provide an example of conjoint measurement as applied to forestry (Brumelle et al, 1988). Conjoint analysis originally developed from mathematical psychology and statistical decision theory and has found wide application in marketing problems.[5] Interactive methods (often using computers) allow the decision maker to experiment with alternatives and examine outcomes. The process itself is intended to clarify preferences over objectives.

The choice between utility elicitation and conjoint scaling or interactive approaches can be divided into conceptual and practical concerns. Conceptually, one would expect that a utility function constructed through a detailed elicitation process would provide a stronger basis for decision making than the implicit utility function derived from conjoint analysis. In practical terms, there are few analysts well trained in utility elicitation, so application of this procedure may be difficult, even though nearly all major decision analysis efforts involve utility elicitation. On the other hand, decision makers may find the ordinal judgements associated with conjoint scaling less demanding that the cardinal judgements associated with an elicitation, particularly for problems involving only a few objectives.

---

[5] One drawback with conjoint scaling is the inability to directly determine risk attitude.

Whichever approach is adopted, explicit development of a value model offers several advantages in analyzing a decision problem. The obvious advantage is that it provides a theoretically sound manner with which to evaluate alternatives involving complex objectives. Other advantages are that such a model can indicate which information is of most interest in the problem, suggest alternatives that may have been overlooked, provide a means to calculate the value of obtaining additional information, and facilitate concise communication about the objectives among interest groups. Finally, a sensitivity analysis of value judgements can be conducted to appraise their importance for the overall decision (Keeney, 1982).

Some critics have suggested that constructing utility models is not applicable to public sector problems because of the lack of a single decision maker. While the existence of multiple decision makers (or many stakeholder groups and no single decision maker) complicates any analysis, modelling values can be highly useful in clarifying these dimensions. Harsanyi (1955) and others have discussed social decision making in conceptual terms: it is necessary to address the relative importance of different decision makers and the relative intensity of the potential effects on each in order to determine an overall utility function. A more heuristic, practical approach is to analyze a decision problem from a number of viewpoints by using the utility functions of different groups. This approach is an extension of the earlier discussion concerned with developing objective hierarchies from different viewpoints. With multiple decision makers, the concept of a single utility function that provides "an answer" to a given problem must be sacrificed, unless restrictive assumptions can be used to narrow the problem. On the other hand, major gains can be achieved in terms of insight into the views of different groups and the ability to conduct sensitivity analysis to better understand the problem.

6.2 Preferences in Forest Allocation Decisions

Because of the intense conflicts over value judgements, efforts to clarify preferences are a crucial step in any analysis of old growth forest decisions. The decision analysis approach would ideally involve development of utility functions over the possible consequences of management options. In the following sections, three key issues in clarifying preferences are discussed:

(1) value tradeoffs;
(2) risk attitudes; and
(3) time preference.

6.3 Value Tradeoffs

Section 6.1 introduced alternative methods for constructing utility functions and identified the steps in a direct elicitation process. For decisions regarding preservation of old growth forests, a direct elicitation between a trained analyst and a decision maker or stakeholder group it would be informative to clarify preferred tradeoffs among relevant objectives. A crucial step, noted earlier, would be to define attributes for each of the lowest level objectives to be considered in the analysis. Then, questions would be used to determine the basic structure of the utility function. In practice, independence concepts (similar to independence in probability modelling) are often employed to permit the use of an additive or multiplicative function, which are widely applicable for many kinds of problems. A linear utility function would have the following structure:

$$u(x) = k_1u(x_1) + k_2u(x_2) + \dots + k_nu(x_n)$$

where $u(x_n)$ refers to a single attribute utility function and k_n is a scaling constant.

Once the general structure of the utility function is established, single attribute utility functions are constructed that represent how moving one single attribute from its worst level to its best changes the resulting utility. Thus, questions of the following nature are asked: "In considering an attribute such as area of wilderness to be preserved, is preserving 50 percent of the area in question half as desirable, in terms of utility, as a hundred percent preservation?"

The next step would be to identify scaling constants. The *k*'s in a linear utility function are effectively coefficients that indicate the relative contribution of each of the single attribute utility functions to overall utility. Thus, the *k*'s can be used to determine the rates at which a decision maker would be willing to forego one objective to improve another within specific ranges. The steps in calculating scaling constants would typically involve questions to establish the order of ranking through pair-wise comparisons, then using questioning and algebra to calculate scaling constants.[6]

Earlier we noted that the elicitation procedure can be difficult to implement because of a lack of trained analysts and because of the judgemental difficulties posed by the questions. In such cases, it may be possible to use less demanding approaches that still provide useful information about value tradeoffs. For example, the SMART approach (Simplified Multi Attribute Rating Technique) developed by Edwards (1986) is a collection of techniques (rather than a single procedure) intended to provide simplified utility assessments, as the name implies. Most of these techniques rely on direct numerical estimation methods as a basis for the required value judgements.

More broadly, qualitative analysis that involves thinking about and comparing objectives can also be useful in clarifying value tradeoffs for a particular decision maker. Although this qualitative analysis may be less defensible in terms of public decision processes, it can be highly useful in helping to inform decision makers without extensive analysis. One qualitative approach to clarifying preferences is to view decisions made today from some point many years in the future. Contemplation of current decisions from a future vantage point can be useful in identifying factors judged to be important now, yet are part of the status quo and so are not obvious as part of the problem. In the context of forest preservation or harvest decisions, it might also be useful to view decisions made twenty years ago regarding the extent of forestry harvest from today's vantage point. What would we tell decision makers of twenty years ago about the implications of their decisions if we could do so today?

---

[6] In some sense, the elicitation methods briefly discussed here are similar to the process of contingent valuation, a technique employed by economists to place values on non-market goods for purposes of benefit/cost analysis (Mitchell and Carson, 1987). However, there are some key differences between utility elicitation and contingent valuation:

(1) The elicitation approach implicit in decision analysis has within it the recognition that not all objectives can be represented in dollar terms. Thus, subjects are not asked to place dollar values on intangibles that are not normally viewed in dollar terms. They are instead asked to specify tradeoffs that naturally arise within the course of the decision problem, which may be cast in terms of dollars, hectares, constructed scales, or other units.

(2) The elicitation approach is more firmly cast within the context of the decision to be made. It is possible to clearly specify who will receive the benefits and who gets the costs if that influences the relevant tradeoffs. Context has been shown to be highly important to evaluations, in both psychological and economic research.

(3) The interactive nature of the elicitation process helps the subject construct or uncover values that were only partially formed. In contrast, the contingent valuation approach involves questions and answers with less regard to helping the subjects clarify their values in order to provide quality responses.

6.4 Risk Attitude

The question of risk attitude essentially involves judgements regarding how decision makers feel about the costs of being wrong or unlucky. Decisions regarding the allocation of old growth forests have inherent risks: some examples would be the costs associated with losing environmental resources and genetic information that could become extraordinarily valuable in future decades. The irreversible nature of these potential losses places a high penalty on being wrong. Economists writing about the issue of risk attitude in the context of public policy decisions have sometimes argued that governments should be risk neutral. That is, governments should not give consideration to risk because the large pool of decisions would tend to have a normal distribution of risks associated with them, providing an acceptable basis for selecting options on the basis of expected value. However, this risk neutrality viewpoint only makes sense in the context of situations where the decision process itself does not systematically underrepresent certain kinds of risks. Nor does risk pooling serve as an adequate basis for asserting risk neutrality if a few of the risks involved have extreme consequences, or if the risks being pooled are incomparable.[7] These points suggest that the issue of risk attitude should at least be explored for decisions regarding old growth forest preservation.

Methods for analyzing risk attitude are well developed in the literature of decision analysis. Von Winterfeldt and Edwards (1986) discuss a number of procedures, all of which involve judgements about the desirability of bets or lotteries that can be used to quantify risk attitude. In practice, judgements regarding risk attitude are probably less demanding than judgements regarding tradeoffs between objectives and should also be more palatable to public decision makers.

---

[7] Moreover, even if risk neutrality can be taken as appropriate, that is, not a rationale for omitting consideration of uncertainty from the analysis. This is a common mistake regarding decision analysis.

6.5 Time Preference

How consequences occurring over time are valued relative to each other is a crucial step in any forest management decision. The standard procedure for handling effects over time is discounting, which involved applying a weighting factor that reflects a particular interest rate to discount effects that occur in the future. Even though economists have written extensively about discount rates, major controversies exist regarding the "right" discount rate for forestry problems.

Perhaps some light can be shed on this issue by explicitly recognizing that the appropriate procedure for comparing effects in the future to effects today is a value judgement. Like other value judgements, there is no single right answer. Analysis that purports to offer the "right" discount rate is overlooking this fact. The degree to which this value judgement is important can be seen in the writing concerned with to sustainable development. That literature argues that much greater attention has to be paid to the effects on future generations of decisions made today (Pearce, Markandya and Barbier, 1989). In effect, the argument is that we should weight long term effects more highly than has been the case in the past. Yet, the effect of the discount rate is to systematically pay less attention to long term effects as every year goes by. Thus, in some sense, discounting is fundamentally at odds with the stated precepts of sustainable development.[8] This point is raised not to argue against the use of a discount rate, but to suggest that how future values are compared to the present should be handled explicitly, like any other value judgement, and not as a mechanistic step in the analysis.

6.6 The Example Revisited

Let us return to the example of Figure 8 and incorporate some of the issues just discussed. Recall the figure describes four alternatives, as well as two sets of uncertainties. The outcomes are described at the end of the decision tree, in terms of performance regarding the two key objectives, *E* and *P*. Suppose a decision analyst has been retained to clarify the preferences of three groups who are viewed as crucial to the decision. The three groups include an environmental interest group that is concerned with forest preservation, representatives of the local community who could be affected, and the forest industry firm that holds the regional license. Interviews are held with each group. In the interviews, questions are asked to clarify the nature of the tradeoffs each group could prefer over the two objectives. In addition, questions clarify attitudes towards risk and time preference, which are important in understanding the weight placed on possible bad outcomes and effects that occur further into the future. A separate value model is constructed that represents the preferences of each of the three groups.

---

[8] Pearce, Markandya and Barbier (1989) would perhaps disagree with this statement. They argue that the discount rate should be used in conjunction with a sustainability constraint on actions.

Using the utility functions for each group, the analysis shows that both the preservation group and the group concerned with the regional economy prefer the option of preservation but with cuts maintained in current levels in the near term, which was the new option introduced in Figure 8. The rationale is that the preservation group would be happy to see the valley preserved and yet have no near term effects on employment in the region. The representatives of the local community favour this option because they foresee the inevitability of employment reductions in any case, and see this as a useful way to phase those reductions in while maintaining the resource base that could provide new employment opportunities in terms of tourism. The forest industry firm clearly prefers the option involving complete harvest of the valley because they stand to lose profits as a result of any withdrawals. However, the industry realizes that opposition to the withdrawal also creates costs to their organization in terms of bad public image. Thus, they have another objective not initially represented in the hierarchy of Figure 4, which has to do with the image of the corporation. In sum, value models can provide insight into the tradeoffs that groups prefer and begin to point the way towards a conclusion.

7.0 EVALUATING ALTERNATIVES FOR FOREST LAND USE

7.1 Overview

The final step in decision analysis is to evaluate and compare alternatives. As discussed earlier the axioms of decision analysis indicate that alternatives should be compared on the basis of the expected utility, $E_j(u)$. The higher the expected utility, the more desirable an alternative. Thus, the magnitude of the $E_j(u)$ can be used to establish a cardinal ranking that indicates the decision maker's preference for alternatives.

When comparing alternatives it is extremely important to examine the sensitivity of the decision to different views about the uncertainties associated with the consequences and to different value structures. Such sensitivity analysis is straightforward in decision analysis because both probabilities and values are explicitly quantified. Once an analysis has been conducted, it is often useful to consider whether the problem should be restructured, or whether more information should be collected on specific elements. The key is to collect information that is sufficiently refined to permit one to make an appropriate decision.

The remainder of this section discusses two aspects of comparing alternatives in old growth forest decisions: analytical practice and the effects of the decision making process itself. Then we return to the example of Figure 8 for a concluding discussion.

7.2 Analytical Practice

As noted above, decision analysis involves selecting between alternatives on the basis of their expected utility, $E(u)$. Expected value, $E(v)$, can be employed in a simplified analysis, or if risk attitude is judged to be less important in a particular problem. Aside from simply identifying the criteria for a decision, analytical practice rests heavily on the use of sensitivity analysis as a means of clarifying the decision. Conflicts regarding old growth forest decisions will inevitably involve major conflicts in values, as well as major uncertainties. A complete analysis would analyze a decision using many combinations of scenarios and values to determine which variable drive the analysis. If, for example, sensitivity analysis indicates that uncertainties over future employment creation in tourism or other sectors drives the analysis, then further resources could be devoted to refining estimates of these employment changes and weighting them with subjective probabilities. Throughout the evaluation phase, emphasis is placed on gaining insight into the problem, by determining which variables have the most influence on the results.

7.3 Effects of the Process

Often the process by which a decision is made is as important as the final choice in determining the acceptability of the result to various parties. Keeney (1982) points out that decision analysis is a highly useful procedure for structuring public decision making. Some of the merits of the decision analysis approach as a basis for a public decision process include the following points:

(1) The procedure is logical, well documented, and open to public scrutiny.
(2) Decision analysis deals directly with the complexities of decisions by considering multiple objectives and uncertainties.
(3) There is a major emphasis on developing an appropriate structure for the decision before any analysis occurs. This structuring phase is often lacking in public decision processes.
(4) The approach is deliberately multi-disciplinary and stresses the need for integrating facts, expert opinion, and values into a unified framework.
(5) A variety of value judgements can be incorporated into the analysis to demonstration their implications for the choice of alternatives.
(6) Explicitly recording objectives crystallizes public debate and spurs creativity regarding new alternatives.
(7) The documentation of objectives can serve as a basis for negotiation to devise compromises.

The last point is a particularly important one for old growth forest decisions. In some sense, these decisions are large scale, public negotiations between stakeholder groups and resource owners.[9] Decision analysis can facilitate negotiations in a number of ways: by clarifying objectives that indicate what is important, by clarifying weights on objectives to allow for tradeoffs between stakeholders, and by providing a logical framework that incorporates diverse sources of information. Raiffa (1982) points out that the more complex are the objectives, the more opportunities may exist to create tradeoffs that are seen as mutually desirable between the negotiating parties. In sum, the decision analysis framework is a good starting point for negotiations regarding old growth forest decisions.

A final point to be made regarding process is to recognize the potential role of mitigation and compensation. If areas are withdrawn from existing commercial forestry licenses, those withdrawals are viewed as a significant loss by the license holders. Psychologists, decision analysts, and economists have demonstrated that losses are felt more strongly than equivalent gains, suggesting that the perceived losses associated with forest withdrawals could be quite severe (Kahneman and Tversky, 1979). In such circumstances, other stakeholder groups, or governments, should consider ways in which losses could be mitigated, or, failing that, ways in which the loser could be compensated. Compensation may be one of the few means available to make the losses associated with withdrawals more palatable to established interests, and so facilitate the process of change in response to a new environmental ethic.

7.4 The Example Revisited

Let us conclude the example that has been developed. Suppose the options have been analyzed with the utility functions for three groups and we have determined preferences for the alternatives as outlined at the conclusion of the previous section. The decision maker in this case would be elected leaders of the province, who act on advice of their professional resource managers. In reviewing the problem, a representative of the forest ministry realizes that there may be opportunities to mitigate the losses to the forest industry firm. The province has unallocated supplies of forest materials available some hundreds of miles away in an area accessible by water. There are a number of disadvantages to that material compared to the forest in contention: the further resources are lower quality, involve higher cost, and provide fewer opportunities to use infrastructure already in place. Nevertheless, there may be opportunities for using some of that material to replace the forest that could be lost due to the withdrawal. Suppose negotiation ensues and a swap of resources is agreed to that also involves reductions in stumpage rates from the provincial forest ministry to compensate for some of the increased costs of the more remote location.

---

[9] In the Pacific Northwest states, the role of negotiation has become even more explicit in old growth forest conflicts. Mediators working with stakeholder groups have developed compromises over short term harvests, in which the US Forest Service essentially acts as an interested observer.

The example demonstrates that by clarifying objectives, thinking carefully about existing alternatives and knowing how new alternatives can be created, clarifying uncertainties, and comparing alternatives from different viewpoints, we can find new creative solutions. A new alternative was created that reduced the effects on local communities by delaying the time when reductions in harvest would occur, and a package of compensation was negotiated that redressed some of the costs borne by the forest industry firm. A combination of insightful analysis, a clear cut process, and creative thinking about new options led to a resolution of the problem.

8.0 CONCLUSIONS

This section offers a few brief conclusions, followed by recommendations regarding subsequent case studies.

Three main themes have been developed in this report:

(1) complexity is an inherent part of decisions regarding allocation of forest lands;

(2) decision analysis can be useful in addressing these complexities; and

(3) there is scope for gaining insight into many specific aspects of forestry problems through some of the techniques and approaches of decisions analysis.

Decision analysis can contribute substantially to clarifying decisions regarding old growth forest allocation. This clarity can come in a better representation and understanding of the value conflicts involved, a better representation of the implications of alternatives, and the creative design of new alternatives that are seen as more attractive by all parties. Yet, if the potential of decision analysis is to be realized, a number of steps are needed.

Sponsoring selected case studies would be a useful step to encourage the application of decision analysis to old growth forestry decisions. These case studies would focus on aspects of the problem that are well suited to the decision analysis approach and for which analysis of a specific issue would contribute to overall understanding of old growth forest decisions. The following topics are suggested as potential case studies:

(1) Extension of the preliminary work discussed in Section 4 regarding the objectives of various stakeholder groups. This case study would involve more stakeholder groups, confirm and clarify the objectives for each group, combine them into an overall objectives hierarchy, then possibly involve elicitation of values across the range of objectives.

(2) A study that involves applying yield analysis approaches (probably linear programming) to examine the effects of withdrawals on harvests over time. The intent would be to investigate whether some of the patterns suggested in Section 5 that involve delays of implementing harvest reductions are feasible.

(3) Development of methods that clarify the role of genetic diversity as a potential tool for environmental risk management. Although genetic diversity has been widely discussed as an impending problem, and diversity is recognized as an indicator of environmental quality, there is no analytical structure that can be used to demonstrate that diversity is valuable. One could develop an argument similar to that developed in portfolio theory, that diversity of environmental resources is valuable in response to uncertainties.

(4) A decision analysis of one old growth forest decision would be useful as a prototype. Perhaps the analysis should be a hypothetical one, in that it could avoid becoming embroiled in controversy over a specific area, but still illustrate the steps involved in such an analysis.

REFERENCES

Barrager, S.M. and Cohan, D. (1968) "The Value of Information in Forest Fire Management Decisions", *TIMS Studies in the Management Sciences*, 21, 403-416.

Bell, D.E. (1977) "A Decision Analysis of Objectives for a Forest Pest Problem", in *Conflicting Objectives in Decisions*, D.E. Bell, R.L. Keeney and H. Raiffa (eds). Wiley: New York, NY.

Brown, T.C. (1984) "The Concept of Value in Resource Allocation", *Land Economics*, Vol. 60, No. 3, pps 231-246.

Brummelle, C., Carley, J.S., Vertinsky, I.B. and Wherung, D.A. (1988). Evaluating Silvicultural Investments: An Analytical Framework", FEPA Research Unit, Working Paper 116, University of British Columbia, BC.

Caulfield, C. (1990) "Ancient Forests", *The New Yorker*, May 13.

Cohan, D., Haas, S. and Roussopoulos, S.S. (1983) "Decision Analysis of Silvicultural Prescriptions and Fuel Management Practices on an Intensively Managed Commercial Forest", *Forest Science*, 29, 4, 858-870.

Cohan, D. et al (1984) "Using Fire in Forest Management: Decision Making Under Uncertainty", *Interfaces*, 14, 5, 8-19.

Fischer, G.W. (1979) "Utility Models for Multiple Objective Decisions: Do They Accurately Represent Human Preferences?", *Decision Sciences*, 10, 451-479.

Fischhoff, B., Slovic, P. and Lichstenstein, S. (1980) "Knowing What You Want: Measuring Labile Values" in T. Wallsten (ed) *Cognitive Processes in Choice and Decision Behavior*, Erlbaum-Hillsdale, NJ.

Holling, C.S. (ed.) (1978) *Adaptive Environmental Assessment and Management*. Wiley: New York, NY.

Harsanyi, J.C. (1955) "Cardinal Welfare, Individualistic, Ethics, and Interpersonal Comparisons of Utility", *Journal of Political Economy*, 63, 309-321.

Hoganson, H.M. and Rose, D.W. (1987) "A Model for Recognizing Forestwide Risk in Timber Management Scheduling", *Forest Science*, 33, 2, 268-282.

Howard, R.R. and Matheson, J.E. (eds.) (1983) *The Principles and Applications of Decision Analysis*, Strategic Decisions Group, Palo Alto.

Kahneman, D. Slovic, P. and Tversky, A. *(1982) Judgement Under Uncertainty: Heuristics and Biases*. Cambridge University Press: Cambridge.

Kahneman, D. and Tversky, A. (1979) "Prospect Theory: An Analysis of Decision Under Risk", *Econometrica*, 47, 263-291.

Keeney, R. (1980) *Siting Energy Facilities*. Academic Press: New York, NY.

Keeney, R. (1982) "Decision Analysis: An Overview", *Operations Research*.

Keeney, R. (1988) "Structuring Objectives for Problems of Public Interest", *Operations Research*,

MacNeill, J. (1989) "Strategies for Sustainable Economic Development", *Scientific American*, 261, 3, 154-165.

Martell, D.L. and Fullerton, J.M. (1987) "Decision Analysis of Jack Pine Management", Working Paper, University of British Columbia, BC.

Mishan, E.J. (1983) *Cost-Benefit Analysis* (2nd Edition), New York: Praegar.

Morgan, G. and Henrion, M. (1990) *Uncertainty: The Treatment of Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press: Cambridge.

Mitchell, R.C. and Carson, R.T. (1987) *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future: Washington, DC.

Pearce, C., McDaniels, T. and Swoveland, C. (1990) "A Framework for Analyzing Silviculture Programs" in Boughton, B.J. and Samoil, J.K. (eds.) *Forest Modelling Symposium*, Forestry Canada, Information Report NOR-X-308, Northern Forestry Centre, Edmonton.

Pearce, D. (1988) "Economics, Equity and Sustainable Development", *Futures*, December, 598-605.

Pearce, D., Markandya, A. and Barbier, E. (1989) *Blueprint for a Green Economy*. Earthscan Press: London.

Pearse, P. (1987) "Property Rights Paper", *Canadian Public Policy*.

Policies in Canada", *Canadian Public Policy*, 14, 3, 307-320.

Raiffa, H. (1968) *Decision Analysis*. Addison-Wesley: Redding, Mass.

Raiffa, H. (1982) *The Art and Science of Negotiation*. Belknap Press: Boston.

Royal Commission on Forest Resources (1976) *Timber Rights and Forest Policy in British Columbia, Vol. I*, Queen's Printer, Victoria.

Savage, L.J. (1954) *The Foundations of Statistics*. Wiley: New York, NY.

Spetzler, C.S. and Stael von Holstein, C.A. (1975) "Probability Encoding in Decision Analysis", *Management Science*, 22, 340-358.

Talerico, R.L. et al (1978) "Pest-control Decisions by Decision-tree Analysis", *Journal of Forestry*, January, 16-19.

Thompson, W., Pearse, P.H., van Kooten, G.C. and Vertinsky, I. (1990) "Rehabilitating the Backlog of Unstocked Forest Lands in British Columbia: A Preliminary Simulation Analysis of Alternative Strategies", FEPA Research Unit, Working Paper 147, University of British Columbia, BC.

Vancouver *Province* (1989) "Poll on the Environment", October.

von Neumann, J. and Morgenstern, O. (1947) *Theory of Games and Economic Behavior*, Edition 2, Princeton University Press: Princeton, NJ.

von Winterfeldt, D. and W. Edwards (1986) *Decision Analysis and Behavioural Research*. Cambridge University Press: Cambridge.

THE USE OF COST-BENEFIT ANALYSIS TO ALLOCATE FOREST LANDS AMONG ALTERNATIVE USES

Background Paper

by

W.T. Stanbury

Ilan Vertinsky

and

H. Thille

Forest Economics and Policy Analysis Research Unit
and
Faculty of Commerce and Business Administration
University of British Columbia
Vancouver, B.C.

1.0 INTRODUCTION

In the past, the allocation of forest land has generally resulted in a single dominant use for specific parcels. Typically, the dominant use was decided by custom and/or the physical and biological suitability of the land. Technological changes and shifts in demand have increased the competition among alternative uses for forest land. However, this increase in competition among users and uses has resulted in only marginal adjustments to the dominant use. The critics of dominant-use management have pointed out that it implies the systematic exclusion from consideration of many other possibilities. Perhaps equally troubling, the analytic basis for the allocation of lands under a dominant-use regime remains unclear. There is no easy means for ranking lands by best use without undertaking a comprehensive analysis which not only considers the physical and biological attributes of the land, but also reflects the value of each particular use to those with a stake in that land (Bowes and Krutilla, 1989).

In British Columbia, over 90% of the forest land is owned by the provincial Crown. Therefore, the method used to allocate it must aim to provide the public with the highest possible net benefits, where benefits and costs are broadly construed. The measurement of benefits, however, reflects not only specific physical outputs, but also value systems. Thus, it depends on the values and preferences of the public operating through political and bureaucratic decision makers. There is wide agreement that, in most circumstances, market mechanisms are the most efficient means for registering the preferences of individuals when alternative uses are competitive, and when prices fully reflect all the benefit and cost dimensions associated with alternative patterns of allocation. The problems with the market mechanism in allocating forest land are (1) market allocations are influenced by the existing distribution of income, and (2) markets often fail to reflect many of the non-timber benefits derived from such land. The diversity of stakeholders, the high degree of uncertainty, and the perception that dedication of the forest to some uses and users results in an irreversible foreclosure of options that others find desirable, are ingredients for polarization and conflict. Polarization means actors take extreme bargaining positions, mistrust is pervasive, and perceptions are often more important than facts. Such circumstances can easily lead to indecision, delays, and uncertainty with regard to the commitment to decisions already made. Indeed, the uncertainties that the decision process creates are sometimes more costly to all stakeholders than are the costs of less-than-optimal decisions. We contend that the technique of cost-benefit analysis (CBA), if properly used, and if carefully interpreted within a process of public participation can result in forest uses which not only represent the "highest net benefit" to the public, but are also perceived to be a fair representation of the public interest. It can also serve to reduce delays and impasses in the decision process. The philosophy of CBA is similar to the "market philosophy" in the sense that options are compared in terms of their benefits minus costs, but differs from it in that it takes into account costs and benefits to all stakeholders not only financially, but in terms of all the outcomes which they value (for which they are willing to make sacrifices).

The advantage of such a process is that it shifts decision making from focusing solely on perceived priorities to a broader perspective which considers necessary trade-offs. Public priorities are important as they provide a measure of the degree of attention that is paid or should be paid to specific objectives of land use. Priorities, however, rarely reflect our abilities to achieve a goal or the sacrifices that must be made to achieve the objectives (or the willingness to make sacrifices). Thus, the priorities of stakeholders are important in determining the "agenda" or scope of the cost-benefit analysis process. They provide benchmarks against which its comprehensiveness can be checked to ensure that each priority dimension is given appropriate weight in the analysis.

In this paper we attempt to provide an overview of the potential use of CBA in allocation of forest land in British Columbia to alternative uses. The paper begins with an overview of the economic approach to the allocation of social resources in Section 2. Section 3 proceeds to define cost-benefit analysis and related techniques. Section 4 outlines the proposed CBA process for forest land use allocation, while the problem of conflicting forest land use objectives is explored in Section 5. The comprehensive and correct measurement of costs and benefits associated with alternative possible forest land use allocations is central to the proposed process. Section 6 provides a review of common issues and conventions in cost and benefit measurement. Section 7 reviews the measurement of benefits and costs in allocating and managing forest lands.

The stream of costs and benefits associated with various alternative forest land allocations accrue in different patterns over time and involve different degrees of uncertainty and risks. Sections 8 and 9 explore how costs and benefits must be adjusted to reflect differences in timing (Section 8) and uncertainty and risks (Section 9) in the analysis. Public participation in different stages of the process is an essential component of the proposed process and is discussed in Section 10. Section 11 presents our conclusions.

2.0 THE ECONOMIC APPROACH

Cost-benefit analysis embodies a comprehensive economic approach to public decision making. Economics deals with the efficient allocation of scarce resources, which requires a comprehensive comparison of the costs and benefits of different options to ensure that the option which maximizes social welfare is chosen. The difference between good economics and bad economics lies in the degree to which the costs, the benefits and the risks of options are fully assessed. Tunnel vision - for example, a narrow focus on financial data - is as antithetical to good economics as is the tunnel vision of those who focus only on the biological aspects of alternatives.

Economists like competitive markets and tend to advocate their use to allocate scarce resources. This is because in a complex world with multiple stakeholders, markets provide the means for allocating resources in an efficient manner without the need for massive information processing capabilities and the high transaction and organizational costs that characterize central planning by government. Economists, however, realize that markets fail to allocate efficiently in the presence of externalities, e.g., production of goods whose full social cost cannot be, or is not, captured by the price mechanism. Despite the observation that they "know the price of everything and the value of nothing," economists do know that prices fail to capture some values, and that prices that capture the full value of resources bring about a more efficient allocation of resources. Thus in assessing the land used for forestry, for example, the economist will not focus only on commercial timber values and other tangible benefits such as tourism and recreation, but will also attempt to assess tangible benefits such as wildlife habitat and water and land conservation, as well as intangible, non-use benefits.[1] These are perhaps the most difficult to assess and therefore are a cause for some underestimation of social values by the economist in forest management unless prodded by an informed public.

---

[1] One should note that what is intangible depends on our ability to articulate fully (define precisely) the consequences of an alternative option. Thus, as the methodologies to assess and measure consequences improve, what is intangible diminishes.

The public, for example, may demand to retain the option to use a forest resource in the future in a manner which cannot be generated at that time and for which no close substitute is available (e.g., wood supply at existing levels). Economists call this "option value." It may also derive value from the knowledge that the resource exists in a specific form such as old growth forests ("existence value"), or it may desire to leave a heritage to future generations ("bequest value"). But such desires must be tempered by their costs (opportunity cost - the value of the next best opportunity foregone) to ensure that the highest net benefit from using the forest accrues to society as a whole.

The ability to measure these values and provide a common denominator for comparisons and to make trade-offs is a requirement of efficient allocation of forest resources. If specific values cannot be measured, or if there is a social decision not to allow some trade-offs, then a constraint on the options considered can be imposed and they can be excluded from the cost-benefit analysis. But such decisions must be made explicitly and defended. Thus the judicious use of cost-benefit analysis depends not only on its comprehensiveness but also on its confinement to those domains where trade-offs are socially acceptable and where social welfare maximization, given the existing distribution of wealth, is a reasonable primary objective. We shall argue in this paper that to reach a comprehensive decision, cost-benefit analysis must be augmented not only by socially imposed constraints on choice, but also by including trade-offs between net benefits as derived by the analysis and consequences in terms of other primary social objectives outside the framework of economic welfare maximization (e.g., regional development objectives).[2]

3.0 COST-BENEFIT ANALYSIS (CBA) AND RELATED TECHNIQUES

CBA starts from the recognition that scarcity prevails: there is an economic problem in the sense that human wants exceed the resources available to satisfy them. This necessitates hard choices if society's welfare, however defined, is to be maximized. CBA and related techniques can help in this process of rational decision making.

Andrews (1982, p. 108) offers a useful definition of what he calls formal cost-benefit analysis:

> [it] is in principle a rigorous, quantitative, and data-intensive procedure, which requires identification of all nontrivial effects, categorization of these effects as

---

[2] Such a modification is often referred to as multiple accounts analysis.

> benefits or costs, quantitative estimation of the extent of each benefit or cost associated with an action, translation of these into a common metric such as dollars, discounting of future costs and benefits into the terms of a given year, and summary of all the costs and all the benefits to see which is greater.

CBA is based on the assumption that the government actions under review produce effects that are marginal to the economy, hence comparative statics analysis is appropriate. The effects are marginal in the sense that they result in relatively small shifts in the allocation of other resources and hence the market prices of goods and services directly affected are appropriate indicators of the value of the alternative. When large shifts result from the allocation of the forest resource, the analyst must use more complex general equilibrium analysis which takes into account the shape of the demand and supply curves of all outputs and inputs affected by the allocation as it "ripples" throughout the economy.

A related technique is **cost-effectiveness analysis.** It

> differs from formal cost-benefit analysis in that it is strictly a comparison among means to a given end. It is used to determine, for example, given a goal of achieving X amount of reduction in air pollution, how much reduction is expected for Y costs associated with a particular action (e.g., a regulation) and whether this is more or less than the cost of an alternative action (or, is there an alternative that could achieve greater reduction for the same or less cost). Unlike formal cost-benefit analysis, it does not attempt to weigh the merits of the goal itself. It does, however, even more clearly require that alternative actions be compared, not simply the costs and effects of a single action (Andrews, 1982, p. 108).

Thus, for example, if the objective is to maintain a certain percentage of the old growth forest, cost-effectiveness analysis will indicate which of the candidates for old growth forests will result in the smallest economic cost. The question of whether to preserve that percentage or any other percentage will not be addressed by the analysis.

The objective of cost-effectiveness (or cost-utility analysis) is to ensure the effective use of inputs. There are two approaches:

> 1. Fixed effectiveness approach. For a specified level of effectiveness to be attained in the accomplishment of some given objective, the analysis attempts to determine that alternative (or feasible combination of alternatives) which is likely to achieve the specified level of effectiveness at the lowest economic cost.
>
> 2. Fixed budget approach. For a specified cost level to be used in the attainment of some given objective, the analysis attempts to determine that alternative (or feasible combination of alternatives) which is likely to produce the highest effectiveness (Fisher, 1971, p. 10).

Cost-effectiveness is used where output cannot be evaluated in economic terms at market prices, but where inputs can be measured in the market, or estimated.

Risk-benefit analysis refers to a set of techniques that attempt to compare the risks of a particular action to the economic value of its benefits. Where an action involves negligible benefits and significant environmental or other risks, the decision is easy. Most cases, however, involve harder choices because, for example, some allocations increase some risks while reducing others, e.g., risks of fire versus land erosion. Where both the adverse consequences and the benefits can be assigned dollar values, the technique is CBA.

CBA and cost-effectiveness are analytic techniques. They do not "make decisions." They are an aid to decision making - a "prerequisite to good judgment" (Treasury Board, 1976, p. 1). Their purpose is to provide a better basis for exercising that judgment by assessing the costs and benefits to society of alternative courses of action. Such techniques are a way of making explicit many of the important elements of a complex decision, such as the assumptions, inputs, outputs, discount rate, time horizon, and changes in prices.

CBA, like all policy analytic techniques, embodies certain values or norms. The frequently stated ideal of "value-free" analysis is, of course, a normative proposition itself. It is also an impossibility. Values implicitly influence all stages of analysis: the choice of the problem, the selection of data, the choice of methodology, the selection of criteria, and the choice of matters to be emphasized in the written report. It is essential, therefore, that the analyst be explicit about the full range of factors that may have a significant impact on the basic criterion, i.e., the net social benefits associated with each alternative considered. These include the limitations in the data or analytic techniques, the degree of uncertainty surrounding estimates (i.e., the limits to one's knowledge), and the assumptions made in the course of the analysis. Public participation is a means to ensure that assumptions are transparent and acceptable, and that if there is doubt or disagreement about an assumption the sensitivity of the choice to that assumption can be assessed. Public participation and scrutiny are especially important since benefit-cost analysis, at the practical level, is as much an art as a science. The information requirements for systematic analysis "often force the [analyst] to fall back on rules of thumb and other short-cut techniques. Elaborate studies are costly and good analysts are often in short supply" (Hettich, 1971, p. 15).

4.0 USING THE CBA PROCESS IN FOREST LAND USE ALLOCATION

Before dealing with some specific issues and conventions in the use of cost-benefit analysis techniques let us outline the process involved and the way it could be employed to allocate forest lands in British Columbia among alternative uses.

The generic structure of the process is the same as any "rational decision process." It begins with a clarification of the objectives that an allocation process is to attempt to achieve, and the constraints that the allocation chosen must meet. Cost-benefit analysis focuses upon the primary objective of maximizing total consumption and production opportunities for people in the system. (We will later propose augmenting the analysis by accounting for other objectives.) In determining the objectives one must also decide what is the referent system or, alternatively stated, what is the locus of analysis. Thus, for example, if the aggregate criterion is to maximize net benefits (benefits minus costs) for the public, one must define what groups of people constitute the public, and what groups of people are external to the system so that benefits and costs accruing to them are not considered in the evaluation process except when they are reflected as altruistic values by those within the system.[3] Of course, one must consider the direct benefits (or cost avoidance) that "environmentally sound forest policy" has in terms of international trade in forest products.

A key element in the process of cost-benefit analysis is the generation of alternatives. One may screen out those alternatives that are clearly dominated by others in the sense of being inferior in meeting all the objectives considered. The cost-benefit analysis process tries to ensure the selection of the best alternative from those being evaluated. If some very promising alternatives are ignored, the choice of an allocation will clearly not be optimal. Indeed, while CBA can be used in conjunction with a variety of land use allocation schemes to choose the best allocation given the system selected, it will reach a better solution if more flexibility is allowed. Thus, for example, if a dominant-use zoning system is chosen, CBA will help choose the best dominant use alternative for each zone. This

---

3. For example, actions to prevent climatic change which may yield benefits to all humanity may be reflected in the cost-benefit analysis not only through calculation of the specific benefits in British Columbia, but also in the pleasure that British Columbians derive from such a contribution to global environmental health.

alternative may be inferior to a scheme which permits flexible multi-use management regimes. On the other hand, for some regions the CBA process may highlight the high management and transaction costs that are involved in multiple-use resource management and hence favour single-use zone designation. Without specifying the use regime, the analyst cannot choose the best regime for each region. However, such flexibility increases the complexity and the cost of the decision process.

The essence of the application of CBA is the measurement of costs and benefits of each alternative. Thus much of the technique is focused on ensuring the comprehensiveness of these costs and benefits without double counting, and on deriving a common metric to ensure comparability (thus, for example, adjusting for the timing of consequences and their level of uncertainty).

CBA concludes with a description of effects which are not considered costs and benefits to the system (e.g., changes in the distribution of income), but which may require an action outside the allocation process to correct for undesirable consequences. Income distributional effects should be assessed and considered in the final selection of alternative policies. In particular, when an allocation of land redistributes benefits and costs in an inequitable way, and it is deemed necessary to correct the inequities, some people in the system may be taxed, with compensation provided to others. If no redress of the inequity outside the allocation process is feasible or desirable, then the consequences of inequity must be considered in the final assessment of the alternatives.

The choice process in CBA is simple in the sense that the alternative which yields the highest level of net benefits (total benefits minus costs) measured on the common metric is the one chosen. The evaluation of benefits and costs in terms of other objectives specified outside the CBA should be done in terms of the same metric. This can be achieved by identifying what trade-offs the decision maker is willing to accept to achieve a particular objective in terms of the loss of economic benefits.

CBA, however, can be an expensive process and its degree of depth and comprehensiveness must depend on the stakes at hand, and on the extent of disagreement with respect to alternative uses. Clearly, if a particular parcel of forest land has marginal value for timber activities and few benefits associated with any other intruding uses, its designation as wilderness area may be obvious even without indepth analysis. Crude cost-benefit analysis may thus be used to screen for land where specific dominant-use zoning (be it timber or wilderness) is obviously indicated.

The major problem that a cost-benefit analysis must solve, however, is the sheer size of the allocation decision that is left after the screening process. Decomposition into regional analyses is required, but such decomposition may lead to decisions reflecting local "costs" and "benefits," without due concern for the costs and benefits to the system as a whole. Indeed, an important element in designing a decomposed decision process is the feedback which is built into a provincial master allocation plan. Such a process must almost inevitably be iterative, i.e., one whereby the cumulative effects of local allocations are reflected in changes in relative value in a provincial master plan for different "cost" and "benefit" dimensions and are fed back to recalculate "local" costs and benefits. For example, if the evaluation can show that, for the province as a whole, biological diversity concerns are satisfied, then the value of preserving diversity within the region will yield the local "benefit" of diversity preservation, but no weight will be placed on its contribution to the provincial "benefit." In a situation where there is a high "deficit" in the attribute from a provincial point of view, such a deficit will be reflected in all local allocation decisions as a benefit even if locally few consider the benefit as valuable.

CBA as we propose it be used calls for an informed "multi-log" of interest groups and individuals at both the provincial and the regional levels to designate province-wide and local objectives, and to define the weights that must be placed on the province-wide objectives as they are reflected in local decisions.

5.0 THE FOREST LAND USE ALLOCATION AGENDA: CONFLICTING OBJECTIVES

Traditionally, attention in managing public forest lands focussed on those activities that generated revenues for the Crown. Thus, timber harvesting received the greatest attention. Some attention was also paid to grazing and mineral development activity. Among the non-market services, recreational use and water flow were probably the highest valued. It was recognized that timber harvesting incurred costs to the public in terms of damage to other forest resources (e.g., wildlife, fish and water) and could require expenditures to mitigate such adverse effects. Timber harvesting, however, led to improvement in access to the forest (e.g., roads) and thereby enhanced recreational use. Mining and livestock grazing imposed costs on the public in terms of their impact upon water quality and localized impact on the aesthetic condition of the forest. Grazing of livestock competed with wildlife grazing, thus reducing recreational opportunities. Within this traditional perspective, the dimensions of the land use allocation problem could be easily reduced into a measurable single dimension for the evaluation of alternatives, i.e., direct or imputed net financial benefits.

While the traditional focus of the land use allocation problem was to try to reconcile conflicting uses, the focus has now shifted into a new domain, that of "non-use" benefits versus the benefits of alternative uses of forest land. The difficulty in evaluating non-use benefits is in identifying those who benefit and measuring the magnitude of the benefit. Non-use benefits vary considerably. Hence, dedication of particular forest lands to non-use benefits may not satisfy some of the latent demands or underlying claims to such benefits.

A review of some of the arguments underlying non-use demands reveals a variety of benefit dimensions that motivate stakeholders. For example, there are those who are concerned with the effects of timber harvesting on the global climate. The major benefits associated with using the forests as "carbon stores" and for carbon conversion accrue mainly globally while the costs are borne locally. The global benefits, however, are relevant to the decision to the extent that the people of British Columbia are willing to internalize these benefits and enjoy their contribution to the prevention of the greenhouse effect. In this case, however, the land allocation process must consider how to achieve the objective without severe constraints on timber harvesting and the economic and social costs they impose.

Demands for preservation of the forest may also be motivated by a desire to preserve the diversity of the biophysical environment to maintain future options for its use and/or to ensure a bequest for future generations. In this case, the question is mainly one of how much to preserve at what cost. Diversity may also be a means to reduce risks from a decline in the biological productive capacity of the forest, and to provide protection from the potential impact of catastrophic diseases or pest epidemics. In this case, the major issue is scientific and other means for risk reduction and improved productivity must be considered as alternatives. Preservation of certain forest lands may be desired to provide a habitat for wildlife. Further, the existence of the forest in its natural state may have an intrinsic value, i.e., value "in and of itself." Preservation of wilderness is desired by others for scientific research as it provides baseline data in attempting to better understand the working of complex ecological interactions and may be a source of genetic information and new organic materials. To some groups in the population (e.g., native Indians) wilderness provides spiritual benefits and reinforces their traditional culture.

Since the forest in B.C. is the most important resource in sustaining the provincial economy and the social structure in many communities, its use in achieving a variety of socio-economic benefits cannot be overlooked. Indeed, the role of the forest as the economic mainstay of certain communities and as a source of "higher quality" employment has, to a large extent, shaped the allocation of forest land and investments in it over the past decade.

A recent survey, conducted to identify priorities among objectives for forest management and investment advocated by regional public representatives (mayors and aldermen), found that in all regions concern about the management of the forest is not limited to one dimension of benefits (Vertinsky et al., 1990). There was, on average, equal concern for managing the forest so as to maintain a healthy environment and for maintaining the forest as a renewable source of timber (see Table 1). Revenue and employment objectives received high weights. Economic development and political concerns received relatively low weights, but they were still significant (see Table 1). The individual variation among regions in priority ratings, especially with respect to the two top overall objectives, reveals the magnitude of value differences in the public and the need to carefully consider the full scope of benefit dimensions.

In analyzing the benefits and costs associated with alternative allocation options one must, however, avoid double counting what are transfers of benefits or costs among stakeholders within the province. A key element in the evaluation of alternatives is the definition and measurement of costs and benefits associated with each alternative. In the following section we summarize some of the conventions and issues that must be addressed in measuring the costs and benefits of each alternative allocation.

6.0 MEASURING COSTS AND BENEFITS: COMMON ISSUES AND CONVENTIONS

6.1 Introduction

CBA is a tool designed to determine whether alternative forms of allocation of our scarce resources make society "better off." The objective of CBA is to determine if the net value of the output in the system with the proposed allocation is greater than the net value of the output under all other possible allocations.

Obviously, the measurement of benefits and costs is the analytical heart of cost-benefit analysis. The analyst tries to identify and measure (to the extent it is efficient to do so) the full range of consequences of policy alternatives for allocative efficiency. This means that tangible and intangible costs and benefits must be considered, that effects years in the future must be taken into account, and that both market and non-market effects must be incorporated into the analysis. In most cases, the specification of "costs" and "benefits" is a matter of the algebraic sign of the consequences: undesirable consequences are called costs and desirable consequences are called benefits.

6.2 Allocative Efficiency

This term is one of the most frequently used in economics and lies at the heart of CBA. Maximum allocative efficiency occurs when it is not possible by altering the configuration of inputs and outputs in the economy to make one or more persons better off without also making someone else worse off.[4] This criterion for allocative efficiency leads to the conclusion that if a change in allocation "results in an increase in utility for at least one individual, and a decrease in utility for none, then there can be no doubt that it is productive of an efficiency, and hence a welfare improvement" (Colvin, 1985, p. 25).

The problem is that most changes in allocation involve an increase in utility (welfare) for some individuals and a decrease for others. Therefore, other criteria have to be developed with the objective of finding agreement on how to define the net effects of an allocation. The one most widely used - and the one that is at the heart of CBA - is the compensation principle.[5] It holds that a change in the allocation of resources yields an improvement in allocative efficiency "if and only if, first, the gainers could have compensated the losers and still been better off and, second, the losers could not have compensated the gainers for their foregone welfare increase without becoming worse off than in the original situation" (Colvin, 1985, p. 26). Note that compensation need not actually be paid.[6]

---

[4] Vilfredo Pareto, a 19th century Italian sociologist and economist, proposed this criterion, emphasizing that it avoids interpersonal comparisons of well-being (utility).

[5] This widely accepted principle was advocated by Kaldor (1939), Hicks (1939) and Scitovsky (1941). More generally, see Little (1957) who discusses their work and proposes his own criterion which incorporates distributional considerations.

6.3 Steps in the Process

In general terms, the measurement of benefits and costs has four steps: identification of the types of effects, quantification in physical terms, dating, and monetization.

(1) Specifying the Types of Effects: The measurement of benefits and costs begins with the specification of the types of effects or consequences associated with the proposed allocation. It is essential to understand the relationship between the allocation desired and its consequences. A model may be helpful here, but the place to start is by thinking about the intended beneficial consequences and then the wider "ripple" effects.

(2) Quantification in Physical Terms: Each type of positive or negative effect (benefit or cost) must be quantified in consistent physical terms. If, for example, an objective of land allocation is the preservation of diversity, the consequences of a particular scheme must first be described in the simplest terms, for example, by the number of species retained in the system and the changes in species mixes. The quantification stage must also specify the degree of uncertainty associated with the estimated consequences. (In a later section we shall explore the means to provide and process information about uncertainties.).

(3) Dating the Benefits and Costs: The third step is to specify the timing of the positive or negative consequences since benefits that will not be received for a decade are not as valuable as those to be received this year. The converse is true of costs, of course.

(4) Reduction to a Common Unit Measure - Monetization: To ensure comparability in evaluating consequences of alternative allocations all consequences must be converted into a common metric. Dollars serve as a convenient, well-understood metric and indeed many of the benefits and costs have a financial dimension. A major problem with using dollars, however, is the reluctance of people to monetize values explicitly, even though in daily life they implicitly do so all the time by deciding how much to spend to promote a specific value. Note that adjustments in the metric must be made to correct for differences in timing and for uncertainties associated with the consequences.

---

[6] One of the justifications for this is that "It is typically infeasible to design a compensation system that ensures that all individuals will be net winners." The transaction costs may simply be too high (Leonard and Zeckhauser, 1986, p. 36).

(5) Time Horizon: In dealing with forest land allocation it is important to consider long time horizons since even timber harvesting can span approximately a century.

6.4 Conventions

In the measurement process the following conventions are observed in CBA:

6.4.1 Measure Costs and Benefits in Constant Dollars: Costs and benefits should be measured in terms of constant dollars so as to abstract from inflation (the change in the average or general level of prices). However, analysts should incorporate anticipated changes in the relative prices of particular cost or benefit items (i.e., prices which rise more slowly or more quickly than average).

6.4.2 Include Only Real Not Pecuniary Effects: A standard problem for CBA analysts is to be able to distinguish real social effects of an allocation from merely pecuniary or distributional ones. Real benefits are those that increase total production and consumption opportunities (i.e., produce a net change in national income). Real costs are just the opposite. On the other hand, pecuniary or distributional effects alter the distribution of consumption opportunities without increasing or decreasing the total benefits to society. While cost benefit analysis in its traditional form ignores distributional consequences, we recommend in forest land use allocation that if undesirable distributional consequences cannot be corrected by means of direct transfers (e.g., compensation) they should be included in the analysis as costs or benefits (e.g., increases in equity or violation of a group's property rights).

6.4.3 Use Shadow Prices to Estimate Benefits and Costs Where Necessary: Shadow pricing involves both the correction of observed market prices and the imputation of prices in non-market exchanges in order to determine the social value of both costs and benefits. The objective is to assign economic values by simulating the outcomes which would prevail if markets both existed and worked efficiently, i.e., were not plagued by such market failures as externalities, market power, public goods, taxes, etc. The core of establishing shadow prices is determining individuals' willingness to pay for the output in question.

Here are three techniques to estimate shadow prices:

> (1) Estimate the users' prices directly by referring to market information where there are near substitutes for collective consumption. The difficulty facing the analyst is that the comparable private commodites are sometimes very different from outputs created by government action.

(2) To estimate what individuals are willing to pay, calculate the cost savings of the public service, that is, the reduction in the costs that individuals would have incurred if the public service were not supplied. This approach is most commonly adopted in the fields of transportation and power.

(3) Consider the public output as an intermediate good and then estimate the value of the marginal product of the good in further production, that is, assume the user is a producer and then ask: by how much does the public output increase his outcome? (adapted from Margolis, 1979, pp. 214, 216, 219).

6.4.4 Use the Willingness to Pay Principle to Value Benefits: In CBA, the economic value of the positive and negative effects attributable to an allocation is based largely on individuals' willingness to pay (WTP). The prices people actually pay represent minimum willingness to pay because they understate what those who received consumer surplus may have been willing to pay. Consumer surplus is defined as the difference between the maximum price an individual is willing to pay for a specified amount of a good (or service) and the price he actually has to pay. WTP is based on the notion of the maximum amount each individual would be willing to pay for a specified amount of a good or service rather than doing without it, i.e., on an all-or-nothing transaction.[7]

6.4.5 Consider Secondary or Indirect Benefits: Secondary benefits are "taken to be those indirectly generated by the resource reallocation either through stimulative effects of the direct outputs or through the demand-inducing effects of the specific allocation" (Haveman and Weisbrod, 1977, p. 146). More generally, Gramlich (1981, p. 83) argues that where a policy action causes a price or quantity change in other markets, this has to be taken into account as a secondary benefit or cost.

Care must be exercised here because, in most cases, so-called secondary benefits are merely pecuniary or distributional effects that should not be counted as an efficiency benefit. The critical issue for CBA analysts is the conditions under which the inclusion of secondary benefits does not amount to merely double counting the benefits. Haveman and Weisbrod (1977, p. 146) offer the following useful and succinct advice: "with relatively full employment

---

7. Willingness to pay and willingness to sell (or give up), apart from transaction costs, should be the same. However, empirically there is some evidence that people demand higher levels of compensation for giving up a benefit than they are willing to pay to acquire it. The argument of which level reflects the "true" price to be used in cost-benefit analysis is not resolved.

there is generally no basis for claiming any secondary effects." When there are no idle resources, any secondary effects do involve the displacement of other economic activity.

6.4.6 Evaluate "Intangible" Benefits (or make the intangible tangible!): Intangibles are "simply some of the consequences of the alternatives compared...[that] cannot be readily translated into the common denominator [usually dollars] that is being used" (McKean, 1958, p. 58). Intangibles include such things as pleasing vistas (including clarity of the air), freedom from nuisance, and various types of irreversible damage such as the loss of a species. It is rare that nothing can be said in quantitative terms about such benefits: "To designate effects as intangible, however, does not imply that it is impossible to conceptualize a monetary value for them. Rather, it implies that with the available data or empirical methods, it is not feasible to place a money value on them" (Haveman and Weisbrod, 1977, p. 15). In other words, intangible benefits are not, in principle, unmeasurable.

Here are several ways of dealing with intangible benefits:

> One reasonable way of dealing with these effects is to describe their nature as explicitly as possible and, where feasible, to describe them in non-monetary, though quantitative, units. Such indicators at least provide information on the importance of the impact, even though its monetary value is still beyond measurement. A second way of proceeding is to establish a reasonable maximum and minimum bound for the value of the unmeasured effect and then to display the effect of both bounds on the final calculation of net benefits. This "sensitivity analysis" approach has the advantage of bringing the intangible effect into an explicit cost-benefit framework. Finally, ...the cost-benefit analysis can be presented in such a way as to indicate how valuable the intangible will have to be if the resource reallocation is to be either economically worthwhile or preferable to some alternative reallocation (Haveman and Weisbrod, 1977, pp. 153-4).

It is our view that the measurement of so-called intangibles is possible and necessary if a rational allocation scheme for forest land allocation is to be adopted. Thus the proposed means should constitute only stop-gap measures until a measurement system is developed for these benefits. Indeed, later in the paper we provide some values which were used to assess benefits that often are designated as intangibles.

6.5 Measuring Social Costs

The calculation of social costs in CBA is usually based on the opportunity cost principle: the true cost of each commodity, service, or consequence in the analysis is its market or imputed (shadow) value in the best alternative use to which it could be put. This means that past investment in forest land is irrelevant except for its effect on the future use of the land as embodied in its present characteristics. Economic costs are benefits lost; they are alternative costs or opportunity costs. Fisher (1971, p. 25) emphasizes that "it is in alternatives, it is in forgone opportunities, that the real meaning of 'cost' must always be found." Costs and benefits, therefore, have the same dimension.

Costs are the consequences of choices: only decisions or choices have costs (but making no choice is a choice in itself). As Fisher (1971, p. 44) emphasizes, "we cannot estimate the consequences or the costs, of any decision, without presupposing some alternative decision or choice." He continues:

> How can we estimate the consequences of a decision? A moment's reflection will assure us that we can only do so by comparing two alternative states of the world. We must estimate what will happen if we make a certain decision and, also, what will happen if we do not, or if we make some other decision. The costs and benefits of a decision lie in the differences between two alternative worlds. Even in retrospect, even after a certain decision has been made and implemented, we cannot fully determine its actual costs or benefits without estimating the different state of the world that would otherwise have ensued (Fisher, 1971, p. 44).

CBA focuses on costs to society, not simply on those accruing to certain individuals or to firms. Social costs can be defined as the total disutility of an activity caused to all members of society measured in monetary terms. In a perfectly functioning competitive economy, private costs and social costs will be equal and hence market prices will be a proper measure of social costs. However, several types of market failures create a divergence between private and social costs: market power/imperfect competition in factor and/or output markets, public or collective goods, externalities ("any interdependency between production and/or consumption functions that is not traded in the market"), imperfect information, and (for some economists) transaction costs.

Here are three approaches to measuring social costs when markets do not properly reflect these costs or where a market does not exist:

> **Imputations From Observed Behaviour**: This approach relies on finding situations in which consumers have a choice between incurring money expenditure and suffering the adverse effect in question. The most successful application of the technique has probably been to the valuation of journey time in transport studies (Harrison and Quarmby, 1971). The choice between a fast journey at a high price and a slower journey at a lower one occurs frequently in practice.
>
> **The Alternative Cost Approach (mitigation costs)**: Where the analyst cannot find hard evidence of the preferences of consumers, he can ask the question, "What would be the minimum money expenditure necessary to remove the ill effect in

question?" This is often presented as an upper limit on the social cost in question, since it will represent the true social cost only in cases in which the expenditure is actually worthwhile rather than accepting a smaller amount of compensation simply to continue to suffer the effect in question.

Survey Techniques to Estimate WTP: Where no market exists to measure social costs, it may be necessary to ask individuals what they would be willing to pay to avoid certain adverse effects. In general, economists have been highly suspicious of the use of survey techniques, regarding what people do as being better evidence of their preferences than what they say, even though they may be acting on faulty knowledge and on a perception of the alternatives, habits or motives which is quite different from that imputed by the researcher. In the closely related field of market research it is generally accepted that survey techniques have a major role to play in assessing WTP (adapted from Nash, 1978, pp. 26-28).

7.0 THE APPLICATION OF CBA IN FOREST LAND ALLOCATION AND MANAGEMENT

The application of CBA to the allocation (and management) of forest land among alternative uses has typically focused on the economic and social aspects of dedicating land to various uses. The approach with respect to non-use values has focused on assessing their opportunity costs rather than quantifying their benefits. Thus, for example, analysis has focused on the economic and social consequences of not using specific forest parcels for timber harvesting by estimating the net costs that result from land use restrictions on timber harvesting after accounting for increases in other user benefits (e.g., recreation), but excluding assessment of non-use benefits. The idea was typically to assume that if such alienation did not appear too costly it should take place. Such an approach is reasonable if it is obvious that one is dealing with a single decision rather than a process of ongoing incremental land use reallocation.

"Creeping change" tends to focus on the low marginal cost of a decision without attention to the possibly very high ultimate cumulative costs. In addition, the "creeping change" process may generate uncertainties and expectations that may damage the economic prospects of the province.

Among user benefits, the most important dimension is usually associated with timber harvesting. The pure economic approach will view "timber" value as the "economic rent" that can be collected by the owner of the resource (i.e., the public in the case of Crown land). Economic rent is the difference between what timber can be sold for and its costs to the owner (or those acting on his behalf) of harvesting it and bringing it to market.

Theoretically, this is the maximum stumpage that can be collected (but not necessarily what the government in fact collects). "Costs" in this context include all payments to factors of production with appropriate profit allowances to retain their services. The value of the "end products" derived from the forests is unimportant as long as one assumes that all production factors are fully employed.

Since we rarely observe full employment of all factors of production, one may wish to account for unemployed factors in CBA. Thus, increases in employment can be considered as a benefit in CBA, but only to the extent that earnings in the forest sector exceed the opportunity cost of those who gain employment. The difference between wages in the forest sector and wages in the worker's next best alternative employment is a net benefit to society (Pope, 1986; B.C. MoE & MoF, 1983; Bowden, 1986). The same argument can be used to partially include foreign exchange earnings in CBA due to trade restrictions and taxes.

Government revenues should not be included separately in CBA if the stumpage calculation is done correctly. Stumpage should be net of taxes paid.

Table 2 lists examples of treatments of timber values in a variety of assessments (CBA and other impact studies) of land use alternatives in British Columbia. Representative values used, their sources or methods of derivation, and comments about the methodologies are provided.

One variable which receives attention in discussions of the regional effects of land use allocation is the impact upon wood supply. In a later section we discuss the relationship between government regulations of the allowable annual cut and the flow of timber benefits. Increases in uncertainty with respect to the wood supply in a particular region (thus possibly affecting other development prospects, community stability and infrastructure) should be reflected in the CBA, as should all transition and adjustment costs brought about by changes in land allocation.

Similarly, costs of "change" must include the externalities imposed upon the system. Thus, for example, if property rights in timber resources are taken away, the impact of such a move on other, not directly affected, property rights holders, as well as prospective bidders for such rights (e.g., new investors), must be assessed in terms of its net impact upon the welfare of the province. Little has been done to assess these effects in British Columbia.

Another market-oriented use of the forest is for grazing. It is the subject of a special paper in this series[8] and will not be included here except to mention that property right issues figure prominently in discussions of this use.

The second forest land use category that has received much attention in CBA and other land use assessment studies is recreation. Table 3 provides examples of the treatment of the recreation benefits of forest land in a variety of studies including details of methodology and representative derived values. The methods typically used for assessing these non-market services were contingent valuation and travel cost studies.

Two other well documented, non-market forest use categories which have received attention are water flow enhancement and the prevention of soil erosion (Bowes and Krutilla, 1989). The local values of these uses may be high, but they can often be accommodated by local adaptation and mitigation.

As noted before, there is little to document bequest, existence and option values of forest lands of different types. Phillips et al. (1989) attempted to capture an amalgam of these three values of the wilderness, the "preservation" value, by using two alternative contingent willingness-to-pay approaches. They asked how much people were willing to donate per year to a wildlife fund to be used for preservation of big game animals in Alberta and, alternatively, asked how much in annual tax increases people were willing to bear to preserve these animals. The average responses were about $80 in donations versus $63 in taxes. The problem with hypothetical questions such as these (apart from the fact that there is little incentive to provide truthful answers) is the fact that it is not clear to respondents what other demands for philanthropic monies or socially oriented sacrifices they may face which may affect their generosity.

Without the documentation of benefits, effective use of public resources is not possible. It is important to transform a variety of now "intangible preservation variables" to tangible variables sorted by function. The following list provides variables that are often mentioned as benefits of preservation which require operationalization, documentation of functions and assessment of values:

- Ecological diversity,
- Genetic information preservation,

---

8. See Van Kooten (1990).

- Resilience,
- Carbon storage and transformation,
- Preservation of unique habitat (e.g., protection of rare species), and
- Scientific information value.

8.0 ADJUSTING FOR TIMING OF THE CONSEQUENCES OF LAND ALLOCATION: THE CHOICE OF DISCOUNT RATES

8.1 Theoretical Issues

One of the most contentious issues in evaluating benefits and costs derived from a particular forest land allocation is the choice of discount rates (Manning, 1977). The idea is to adjust costs and benefits which occur in different times so they can be compared at a common point in time. This is necessary when people are not indifferent about a consequence of the land allocation occurring now or sometime in the future. When dealing with streams of financial payoffs it is clear that money spent now could have alternative beneficial uses if the time of expenditure was in a later period (e.g., earning risk free interest when invested in government bonds). However, even when dealing with financial expenditures or returns there are several schools of thought and many diverse institutional practices concerning choice of a discount rate.

It is argued that, from the system's perspective, an allocation which yields less than other feasible allocations would reduce total output in the system in real terms. Choice of the appropriate discount rate will ensure that public decisions will not result in a reduction in society's welfare. Most of the discount rates used are based on the concept of displaced private investment and thus are a measure of the opportunity cost of capital. However, some argue that the opportunity cost of capital is irrelevant to the choice of social investments and that it is the social rate of time preference that matters. This reasoning is based on the idea that society, through its governing institutions, has some rate of exchange at which it is willing to sacrifice present consumption for future benefits. The opportunity cost of capital which is reflected in the market may not be equal to the social rate of time preference. Indeed, it is usually suggested that the former exceeds the latter.

There are many economists who argue that private rates of return and private rates of interest determined by the market bear no systematic relationship to the discount rate to be used in evaluating the consequences of social decisions. Lind (1982, p. 56) expresses this view as follows:

> One line of argument that leads to this conclusion is based on a concept of the state as an entity with an existence and objectives totally separate from, and independent of, its individual citizens. Put differently, under such a theory the state is the guardian of the national interest, which goes beyond the interests and the preferences of the individual citizens of that state... The social rate of time preference under such a theory would be politically determined on the basis of politically determined goals.

But Lind also suggests that politicians must consider the displacement effects of public decisions on private investment decisions. Thus the concept

> underlying the academic literature on public sector discounting is that economic welfare is ultimately determined by consumption and only indirectly by investment. Therefore the value of investment must be measured by the value of subsequent increases in consumption it permits. Any effect that a government program has on investment must be converted to an equivalent time-stream of consumption before being discounted. In practice, this results in a complex procedure that uses before-tax and after-tax discount rates, a 'shadow price of capital' and the impacts of benefits and costs on investment (U.S. Exec. Order 12291, 1981, p. 506).

Even if one considers a government which reflects the preferences of its citizens, one may still argue that private and social rates need not be the same. Through their government, people may choose to increase their total savings for the benefit of future generations above the level they choose privately through their investment and borrowing behaviour. This point has long been emphasized by Sen (1967; 1970).

When dealing with non-market benefits and costs, the above arguments are not particularly relevant. Rather, it is the subjective preferences of the stakeholders or the representatives of the public as a whole (e.g., the legislature) for timing (what is called social time preference rate) of every specific dimension that should count. Indeed, there are dimensions of consequences where discounting does not make any sense. For example, if one of the derived "benefits" of land allocation is the preservation of the long term diversity of the system, it is the distant future that counts, not the present (in particular if the process of diversity reduction is irreversible).

8.2 What Rate to Choose?

Lind (1982, p. 77) summarized the issue of what discount rate to choose by stating that:

> Whatever theory we use for the social rate of discount, there is still the problem of computing the appropriate number or numbers for the discount rate, given the underlying conditions in the economy in a procedure we adopt. This task is by no means trivial.... The major contenders for the social rate of discount are the

> marginal rate of return on private capital, the consumption rate of interest taken as a measure of the social rate of time preference, a weighted average of the consumption rate of interest and the marginal rate of return on private capital, and a social rate of time preference revealed through the political process.

In Table 4 we present examples of alternative rates which have been used for discounting in social choice processes and the arguments (if any were given) in support of particular discount rates.

8.3 Timing and Government Regulation of Forest Land Use

An issue which is important in evaluating timber benefits from public forest land is the impact that government regulations have on the timing of benefits. For example, by adopting a sustained yield regime and deciding on the allowable annual cut, the regulator in fact determines to an extent the (maximum) flow of harvested timber. A change in the regime (or a change in the calculation method in implementing the regime) could change the flow of benefits. It is important to realize that a change in regulation that leads to a different flow of benefits over time may affect land use determination. It is necessary therefore, to examine whether the method assumed in the CBA for calculating the allowable annual cut is appropriate and whether the choice of land use is sensitive to this method.

9.0 ADJUSTING FOR UNCERTAINTY

9.1 Expected Values

There is little disagreement among policy analysts with Sugden and Williams (1978, p. 54), who observed that

> One starting-point is to assert that rational choice under uncertainty should be based on judgments about relative likelihoods or probabilities of particular states of the world occurring. This seems intuitively reasonable. The more likely is a particular state of the world... the more account should be taken of the implications of this state when making decisions.

When numerical probabilities are specified for the different potential states of the world on which outcomes depend, it is possible to present the consequences of a given action in terms of a probability distribution. If one is indifferent between getting a particular outcome for sure and obtaining the outcome on average in repeated decisions, then one could choose among alternatives by comparing the mathematical conditional expectation of outcomes for each alternative decision.

9.2 Diversification

The use of expected outcome values has characterized most of the formal decision models of decision making under uncertainty in forest management. One argument which has been used to justify such handling of risk valuation has been risk diversification, especially when public policy choices are involved. This argument is based on the idea that with a large number of investments, statistical laws predict that the mean of realized outcomes will converge to the expected value (see, e.g., Arrow and Lind, 1970). This proposition ignores several important factors:

1. Some risks with a low probability of occurrence have large catastrophic effects which are unacceptable to the public.
2. Probabilities of risks associated with specific actions may not be independent from other actions. Thus the idea of cancellation of variations about the mean with a large number of trials does not apply (e.g., consider the probability of epidemic infestations of spruce budworm given outbreaks in several stands).
3. The decision maker may treat losses differently from gains. Hence, an allocation with expected net benefits that involves the possibility of losses may not be as attractive as an allocation with lower expected benefits that involves no possibility of losses at all.

A decision framework for land allocation with risks, benefits and costs must separate diversifiable risks from non-diversifiable risks. For non-diversifiable risks adjustment of benefits and costs is necessary.

9.3 Deriving Risk-Adjusted Benefits and Costs

9.3.1 Market Evaluation of Risk Adjustments: Sharpe (1964) and Lintner (1965) proposed the Capital Asset Pricing Model (CAPM) to assess the adjustment in rates of return on commercial-financial investments that is needed to account for their risk. They asserted that people generally prefer less risky or less variable prospects of benefits than prospects with equal expected values that are more variable. However, the adjustment in the required rate of return was only for risks that could not be eliminated by diversification, as we have already noted. Therefore, the sensitivity of an investment opportunity to market variability defines the systematic risks associated with it which require compensation. This sensitivity is called beta. Beta is a measure of the non-diversifiable potential variation of the returns from the investment. Risk-averse investors (generally assumed to comprise the majority of investors in society) demand a premium return on risky projects as compared with risk-free alternatives.

The CAPM stipulates that risk premiums on investments vary in direct proportion to beta. The expected market risk premium on a security is defined to equal beta multiplied by the expected risk premium over the market. The latter is the difference between expected return on the entire portfolio of investments available in the market and the return on a risk-free investment such as treasury bills.

This theory can be used to find the certainty equivalents of investments in silviculture having varying degrees of risk. The evaluation within an investment portfolio must consider the correlation of the returns of a particular project with the total portfolio of investments. Indeed, if a particular type of investment is expected to yield returns which are negatively correlated with the other projects in the portfolio, the adjustment for risk would be negative. The CAPM provides a means for adjusting returns for risk in calculating the opportunity cost of capital, but it is irrelevant to the evaluation of societal risk preferences for non-market benefits. In such a case the preferences of the decision maker must be evaluated.

9.3.2 Non-Market Evaluations of Risk Preferences: Economists incorporate all considerations of value into one function. Derivation of a function which reflects this information is possible if certain assumptions are made about the "rationality" of the decision maker. This "utility function" represents the objective function whose expected value one attempts to maximize in choosing investments (Von Neumann and Morgenstern, 1944; Keeny and Raiffa, 1976). There are several problems in deriving the information needed for such a function. For example, to estimate a utility function one must compare risky and sure prospects and thus indicate trade-offs between them. Most people have a very difficult time making such judgments consistently and logically (Kahneman et al., 1982).

The basic idea of the approach is to reduce all uncertain benefits and costs to a common framework of certainty equivalents. These are the minimum "benefits" that people are willing to accept with certainty instead of choosing a specified alternative with uncertain benefits. Alternatively, the certainty equivalent is the maximum cost that people are willing to incur with certainty instead of having to accept a specified alternative with an uncertain cost.

Arriving at agreement on certainty equivalents may not be easy when diverse groups of stakeholders are involved. The alternative is to reach a consensus on what is an unacceptable risk and eliminate those alternatives from further consideration that do not meet the threshold of acceptability. The analysis with the remaining alternatives may use expected values.

10.0 PUBLIC PARTICIPATION AND COST BENEFIT ANALYSIS

Since forest land is the most important natural resource in British Columbia and its allocation among uses may affect the well-being of almost every citizen, public participation in the process of allocation is a necessary condition for a decision process which is credible and results in maximum net benefits for the public. The use of CBA can be a particularly effective method of including public participation as a means of improving the quality of decisions made. The transferability of assumptions, data bases and value judgments in the analysis allows public scrutiny and encourages the development of an informed position by stakeholders.

Necessary inputs from the public in CBA are those which permit the derivation of common valuation metrics for non-market benefits and costs. Public surveys are an important means of establishing willingness to "trade-off" or "pay" for some benefits (including so-called intangibles) in terms of others. Clearly the process of derivation of such socially sanctioned "trade-offs" must be well understood and meaningful to participants.

There are, however, other elements of the decision process to which the public at large can contribute either directly or through its representatives. The generation of innovative options ensuring that all possible efficient alternatives be considered, the insistence that all important benefits and costs associated with an alternative are taken into account, and the registration of objections to assumptions made in the absence of scientific information or data, are functions best served by participation through public hearings. These would involve public interest groups, specific stakeholders, and those individuals from the public with special knowledge of or interest in the issue at hand. Advisory committees representing stakeholders and groups with special knowledge (e.g., foresters, environmental scientists) can serve as continuous channels of feedback, ideas and information to the analysis and decision-making process. Such committees can also serve to inform and educate the public and mobilize support for decisions once they are reached.

Indeed, the involvement of the public at large through information sessions, where options and their consequences are explained, is a means to ensure not only that divergent voices of the public are heard, but also that the decisions later made are understood and the integrity of the process is preserved. It is clear that the social costs of a process of forest land allocation that is not trusted, even when it produces "good" decisions, may be high in terms of conflict, social disruption, expensive administration and enforcement and the creation of a highly uncertain economic and social environment. Indeed, the integrity and perceived integrity of the process of analysis and decision making are as important as the "efficiency" of the allocations themselves. In the context of modifying CBA to make it more comprehensive and acceptable to the public and other decision makers, "distributional" and "political" concerns not addressed by the traditional application of the technique must be dealt with in the evaluation process.

11.0 CONCLUSIONS

It is widely agreed that public forest land in B.C. should be allocated so as to maximize the net benefit to society as a whole. This means:

(1) incorporation of social values in the decision process articulated as preferences and trade-offs among conflicting objectives;

(2) the use of the most appropriate data base and technical and scientific know-how to the extent practicable;

(3) the explicit recognition of the role of assumption making and other sources of uncertainty in the analysis and choice process;

(4) the elimination in the choice process of alternative forest land allocations that are dominated by others in the sense that they provide fewer or the same benefits to all stakeholders as other alternatives. (This is the principal criterion of efficiency which ensures that conflict only arises when no "win-win" alternative options are available.)

Comprehensive cost-benefit analysis (augmented by accounts of other primary social objectives) provides a framework of choice that satisfies these criteria.

To be comprehensive, the framework must consider all benefits and costs and be able to reduce them to a common metric that reflects social trade-offs. This means that no important benefit or cost dimensions can be excluded from the analysis as intangible or unquantifiable. Indeed, whenever "trade-offs" are made by society with respect to a benefit or a cost it is possible to quantify its value in terms of this "trade-off." The willingness-to-pay (WTP) principle is central to such quantification and is the core principle of cost-benefit analysis. In deciding upon "trade-offs" outside the scope of cost-benefit analysis and its "market" or "simulated market" pricing concept, it is the "willingness to pay" by the authorized decision maker (e.g., government) that counts. If "trade-offs" are not acceptable with respect to some outcomes (e.g., unacceptable environmental risks), such constraints must be identified explicitly and used as screening devices to eliminate alternatives before the application of cost-benefit analysis. It is, however, desirable to assess the "costs" of such constraints to society. (Indeed in some circumstances constraints which appear to command consensus in principle are much less acceptable when their costs in terms of public benefit are made explicit.)

Given the importance of social values and assumption making in the application of cost-benefit analysis to the problem of forest land allocation, public participation is necessary. This participation can take the form of:

(1) Surveys of the preferences of the public to establish value metrics reflecting trade-offs through willingness-to-pay evaluation.

(2) Open public hearings to generate alternatives and inform the public about the process and its outcomes.

(3) The use of advisory committees with representation of a variety of stakeholders to ensure:

    (a) the comprehensive consideration of all value dimensions involved in forest allocation;
    (b) the generation of imaginative forest land allocation options;
    (c) the scrutinization of assumption making; and
    (d) the highlighting of "equity" problems.

The major advantages of cost-benefit analysis are transparency of assumptions and value judgements and the ease with which sensitivity analysis can be conducted, and a focus on "efficiency" in terms of social welfare maximization. The major theoretical problem is the fact that traditional cost-benefit analysis is based on one primary objective (social welfare maximization given the current distribution of wealth). This difficulty is resolved in our proposal by augmenting the choice process by considering trade-offs of consequences in terms of a broader range of primary objectives.

The major practical problems with cost-benefit analysis are its "hunger for data" and other forms of information, and its requirement for the quantification of values. This latter requirement will necessitate a major research effort to ensure that the process of value quantification accurately reflects social preferences and is acceptable to the stakeholders.

In the context of British Columbia, we recommend a "decomposed" cost-benefit analysis whereby province-wide objectives are reflected in regional analyses. An iterative process of adjusting the "provincial" component in each regional analysis will ensure the reconciliation of provincial and regional points of view in the allocation of forest lands among competing uses.

REFERENCES

Adamowicz, W.L. (1983) "Economic Analysis of Hunting of Selected Big Game Species in the Eastern Slopes of Alberta" (Unpublished M.Sc. Thesis, University of Alberta, Edmonton).

Anderson, F.J. (1979) "Ontario Reforestation Policy: Benefits and Costs," *Canadian Public Policy*, Vol. 3, pp. 336-47.

Andrews, Richard N.L. (1982) "Cost Benefit Analysis as Regulatory Reform" in D. Swartzmann, R.A. Liroff and K.G. Croke (eds.) *Cost Benefit Analysis and Environmental Regulations* (Washington, D.C.: The Conservation Foundation), pp. 107-135.

Arrow, K.J. and R.C. Lind (1970) "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review*, Vol. 60, June, pp. 364-78.

Asafu-Adjaye, John, Wiktor Adamowicz and William Phillips (1989) *Nonmarket Valuation under Uncertainty*, (Department of Rural Economy, Faculty of Agriculture and Forestry, University of Alberta, Edmonton, Staff Paper No. 89-15, September).

Bernstein, P. (1974) "Are Common Stocks Really Good Investments?" *Challenge*, Vol. 17(3), pp. 56-61.

Boadway, R.W., N. Bruce and J.M. Mintz (1984) "Taxation, Inflation and the Effective Marginal Tax Rate on Capital in Canada," *Canadian Journal of Economics*, Vol. XVII, pp. 62-79.

Bodden, K. and P. Lee (1986) "The 1985 Economic Survey of Alberta Resident Pheasant Hunters," Alberta Forestry Lands and Wildlife, Fish and Wildlife Division, Technical Report No. 1.

Bowden, G.K. (1986) *Economic Implications of Alternative Developments in the Stein River Valley*, Prepared for the Wilderness Advisory Committee.

Bowes, M.D. and J.V. Krutilla (1989) *Multiple Use Management; The Economics of Public Forest Land* (Washington: Resources for the Future).

British Columbia Forest Products Ltd. (1986) *Economic Factors Pertaining to the Development of the Stein Valley*, Submitted to the Wilderness Advisory Committee, January 6, 1986.

British Columbia Ministry of Environment and Ministry of Forests (1983) *Reservation of Old Growth Timber for the Protection of Wildlife Habitat on Northern Vancouver Island* (Victoria: MoE, MoF).

British Columbia Ministry of Forests Strategic Studies Branch (1983) *Impact Analysis: The Cost of Establishing Deer and Elk Reserves in TFLs 37 and 39* (Old Growth Vancouver Island Study, MoF).

British Columbia Ministry of Forests, Vancouver Region (1985) *Fraser Timber Supply Area Options Report* (Vancouver: MoF).

Burgess, D.F. (1981) "The Social Discount Rate for Canada: Theory and Evidence," *Canadian Public Policy*, Vol. VII, pp. 383-94.

Colvin, Phyllis (1985) *The Economic Ideal in British Government: Calculating Costs and Benefits in the 1970s* (Dover, NH: Manchester University Press).

Copeland, G. (1985) *A Study of the Tourism Development Potential of the Stein Wilderness Area* (Prepared for the Institute for New Economics, Vancouver, B.C.).

Dobie, James (1988) "Some Economic Aggregates for Canadian Forest Industries," *The Forestry Chronicle*, August, pp. 355-59.

Faustmann, Martin (1849) "On the Determination of the Value Which Forest Land and Immature Stands Possess for Forestry," English edition in M. Gane (ed.) (1968) *Martin Faustmann and the Evolution of Discounted Cash Flow* (Institute Paper No. 42, Commonwealth Forestry Institute, Oxford University).

Fisher, Gene H. (1971) *Cost Considerations in Systems Analysis* (New York: Elsevier).

Gramlich, Edward M. (1981) *Benefit-Cost Analysis of Government Programs* (Englewood Cliffs, N.J.: Prentice-Hall Inc.).

Griffen, D.E. (1984) *Substitution Among Recreation Sites: An Analysis of Cross Elasticity Results* (M.A. Extended Essay, Simon Fraser University).

Gunton, T. J. Richards et al. (1985) *Stein River Watershed Resource Evaluation* (Vancouver).

Harrison, A.J. and D.A. Quarmby (1971) "The Value of Time" in R. Layard (ed.) *Cost-Benefit Analysis* (Harmondsworth: Penguin Books), pp. 173-208.

Haveman, R.H. and B.A. Weisbrod (1977) "Defining Benefits of Public Programs: Some Guidance for Policy Analysts" in R.H. Haveman and J. Margolis (eds.) *Public Expenditure and Policy Analysis* (Chicago: Rand McNally), pp. 135-160.

Heaps, Terry (1985) *An Analysis of the Present Value of Stumpage Under a Variety of Economic and Management Conditions* (Economic Council of Canada, Discussion Paper No. 284).

Heaps, Terry and Brian Pratt (1989) *The Social Discount Rate for Silvicultural Investments* (Study prepared for B.C. Ministry of Forests, Industry Development & Marketing Branch).

Helliwell, John F., Gordon R. Sparks and J. Frish (1973) "The Supply Price of Capital in Macroeconomic Models" in A.A. Powell and R.A. Williams (eds.) *Econometric Studies of Macro and Monetary Relations* (Amsterdam: North Holland), pp. 262-83.

Hettich, Walter (1971) *Why Distribution is Important: An Examination of Equity and Efficiency Criteria in Benefit-Cost Analysis* (Ottawa: Economic Council of Canada/Information Canada).

Hicks, J.R. (1939) "The Foundation of Welfare Economics," *Economic Journal*, Vol. 49, pp. 696-712.

Howard, W.G. (1978) *Estimates of Taxes, Fees and Royalties Paid by the B.C. Forest Industry and Employees: 1971-75* (Victoria, B.C.: Canadian Forestry Service, Report No. BC-X-181).

Hynard, P.P. (1986) *A Decision-Making Model for Forest Managers using Economic Considerations* (Ontario Ministry of Natural Resources).

Jenkins, G.P. (1973) "The Measurement of Rates of Return and Taxation from Private Capital in Canada" in W.A. Niskanen et al. (eds.) *Benefit-Cost and Policy Analysis in 1972* (Chicago: Aldine), pp. 211-45.

Jenkins, G.P. (1980) "Discount Rates for Economic Appraisal of Public Sector Expenditures," *Canadian Public Policy*, Vol. 4, pp. 549-55.

Jones, Trevor (1983) *Wildnemess or Logging? Case Studies of Two Conflicts in B.C.* (Vancouver: Federation of Mountain Clubs of British Columbia).

Kahneman, D., P. Slovic and A. Tversky (1982) *Judgement Under Uncertainty: Heuristics and Biases* (Cambridge: Cambridge University Press).

Kaldor, N. (1939) "Welfare Propositions of Economics and Interpersonal Comparisons of Utility," *Economic Journal*, Vol. 49, pp. 549-552.

Keeny, R. and H. Raiffa (1976) *Decisions with Multiple Conflicting Objectives: Preferences and Value Trade-offs* (New York: Wiley).

Leonard, H.B. & R. Zeckhauser (1986) "Cost-Benefit Analysis Applied to Risks: Its Philosophy and Legitimacy," in D. MacLean (ed.) *Values at Risk* (Totowa, N.J.: Rowman & Allanheld).

Lind, R.C. (1982) "A Primer on Major Issues Relating to Discount Rates for Evaluating Energy Options" in R.C. Lind et al. (eds.) *Discounting for Time and Risk in Energy Policy* (Washington, D.C.: Resources for the Future), pp. 21-99.

Lintner, J. (1965) "The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics*, Vol. 47, pp. 13-37.

Little, I.M.D. (1957) *A Critique of Welfare Economics* (Oxford: Clarendon Press).

Loose, V. (1977) *Guidelines for Benefit Cost Analysis* (Study prepared for the Environmental and Land Use Secretariat, Victoria, B.C.).

Lytton Lumber Ltd. (1985) *Submission to the Wilderness Advisory Committee*.

MacMillan Bloedel Limited (1983?) *Reservation of Old Growth Timber for Protection of Wildlife Habitat on Northern Vancouver Island: A Submission* (Vancouver: MacMillan Blodel Limited).

Manning, G. (1977) "Evaluating Public Forestry Investments in British Columbia: The Choice of Discount Rate," *Forest Chronicle*, Vol. 53, pp. 151-58.

Margolis, J. (1979) "Shadow Prices for Incorrect or Nonexistent Market Values" in R.H. Haveman and J. Margolis (eds.) *Public Expenditure and Policy Analysis* (Skokie, Ill.: Rand McNally), pp. 209-20.

McDaniels Research Ltd. (1980) *An Evaluation of Wildlife Enhancement through Silvicultural Changes in the Sayward Forest* (Study prepared for the Ministry of Forests, November).

McDaniels, T. (1990) "Decision Analysis: A Tool for Gaining Insight Into Forest Land Conflicts" (Background Paper, McDaniels Research Ltd.).

McKean, R.N. (1958) *Efficiency in Government Through Systems Analysis* (New York: Wiley).

Miller, R.J. (1971) "Alberta's Hunting and Fishing Resource: An Economic Evaluation" (Econmics Division, Resource Economics Branch, Alberta Department of Agriculture).

Mishan, E.J. (1976) *Elements of Cost-Benefit Analysis*, 2nd ed. (London: George Allen and Unwin).

Nash, C.A. (1978) "The Theory of Social Cost Measurement" in D.W. Pearce (ed.) *The Valuation of Social Cost* (London: Allen & Unwin), pp. 8-30.

Nordaus, W.D. (1974) "The Falling Rate of Profits" in *Brookings Papers on Economic Activity*, Vol. X, pp. 169-208.

Pattison, W.S. (1970) "Moose Hunting Activity in Northern Alberta: A Case Study in Wildlife Economics" (Unpublished M.Sc. Thesis, University of Alberta, Edmonton).

Pearse, P.H. and G.K. Bowden (1977) *Fish and Wildlife in British Columbia: A Review of Resource Values* (Report prepared for the Fish and Wildlife Branch, Victoria).

Phillips, W.E., D. DePape and C. Ewanyk (1977) "Socioeconomic Evaluation of the Recreational Use of Fish and Wildlife Resources with Particular Reference to the AOSA, Volume 3: Recreational Hunting" (Department of Rural Economy, University of Alberta).

Phillips, W.E., W.L. Adamowicz, J. Asafu-Adjaye and P.C. Boxall (1989) *An Economic Assessment of the Value of Wildlife Resources in Alberta* (Alberta Recreation, Parks and Wildlife Foundation, Project Report No. 89-04, August).

Pope, Liz (1986) *Using Cost-Benefit Analysis to Evaluate Forest Land Use Alternatives* (Natural Resources Management Program, Simon Fraser University, Research Report No. 40).

Prather, R.A. (1974) "Alternative Methods of Estimating Benefits: An Economic Evaluation of Big Game Hunting in Alberta" (Unpublished M.Sc. Thesis, University of Alberta, Edmonton).

Prins, Robert, Wiktor Adamowicz and William Phillips (1990) *Non-Timber Values and Forest Resources: An Annotated Bibliography* (Department of Rural Economy, University of Alberta for Forestry Canada, Project Report No. 90-03).

Reed, F.C.L. and Associates Ltd. (1975) *The Forest Industry; Its Impacts on the Economy* (Prepared for the Ministry of Forests, September).

Reuber, G.L. and R.J. Wonnacott (1961) *The Cost of Capital in Canada* (Washington, D.C.: Resources for the Future).

Row, C., H.F. Kaiser and J. Sessions (1981) "Discount Rate for Long-Term Forest Service Investments," *Journal of Forestry*, Vol. 79, pp. 367-69, 376.

Scitovsky, Tibor (1941) "A Note on Welfare Propositions in Economics," *Review of Economic Studies*, Vol. 9, November, pp. 77-88.

Sen, A.K. (1967) "Isolation, Assurance and the Social Rate of Discount," *Quarterly Journal of Economics*, Vol. 81, February, pp. 112-124.

Sen, A.K. (1970) *Collective Choice and Social Welfare* (San Francisco: Holden-Day).

Sharpe, W.F. (1964) "Capital Assets Prices: Theory of Market Equilibrium under Conditions of Risk," *Journal of Finance*, September, pp. 425-442.

Shepard, W. (1925) "The Bogey of Compound Interest," *Journal of Forestry*, Vol. 29, pp. 251-59.

Simon Fraser University, Natural Resources Management Program (1990) *Wilderness and Forestry: Assessing the Cost of Comprehensive Wilderness Protection in British Columbia* (Vancouver: SFU-NRM Report No. 6).

South Moresby Resource Planning Team (1983) *South Moresby: Land Use Alternatives* (British Columbia Ministry of Forests).

Spiro, P.S. (1987) "Public Utility Finance and the Cost of Capital: Comments on Jenkins," *Canadian Journal of Economics*, Vol. 20, pp. 164-71.

Stanbury, W.T. and Ilan B. Vertinsky (1989) *Guide to Regulatory Impact Analysis* (Ottawa: Office of Privatization and Regulatory Affairs, June).

Sugden, R. and A. Williams (1978) *Principles of Practical Cost-Benefit Analysis* (Oxford: Oxford University Press).

Treasury Board of Canada (1976) *Benefit-Cost Analysis Guide* (Ottawa: Queen's Printer).

United States Executive Order 12291 (1981) Federal Regulation. United States Government.

United States Water Resources Council (1983) *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (Washington, D.C.: Government Printing Office).

Van Kooten, C.G. (1990) "Multiple Use of Forest Lands: The Role of Rangeland" (Background Paper, Department of Agricultural Economics, University of B.C.).

Von Gehren, _ (1849) "On Determination of the Money Value of Bare Forest Land," *Allg. Forst Jagdzt*, Vol. 24, pp. 361-66 (translated by W. Linnard, Commonwealth For. Inst. Paper No. 42).

Von Neumann, J. and O. Morgenstern (1941) *Theory of Games and Economic Behavior* (New York: Wiley).

Vertinsky, Ilan, Don Wehrung and Shelby Brumelle (1990) "Priorities for Silvicultural Investments: Public, Government and Industry Perspectives" (FEPA Working Paper 146, University of British Columbia, June).

Wood Gundy Ltd. (1977) *Canadian Economy Forecast* (Toronto).

Table 1

Mean priority ratings of regional public representatives for aggregate objectives in respect to the use of forests in British Columbia

Objective	Significant differences	Total Sample	Vanc.	Prince Rupert	Prince George	Kamloops	Nelson	Cariboo
Generate revenue	NS	17.2	18.8	16.7	14.7	17.6	11.3	25.6
Maintain healthy environment	p=.0404	23.2	27.4	25.4	15.3	21.9	30.1	16.9
Maintain forest as a renewable source of timber	NS	25.9	23.2	25.3	31.3	26.0	22.6	25.0
Generate development opportunities	NS	10.6	8.0	13.7	13.9	10.5	9.3	11.3
Meet political considerations	NS	7.5	8.8	3.7	7.5	9.3	9.0	8.1
Generate employment	NS	15.1	13.8	15.1	17.3	14.8	17.7	13.1

NS = no statistically significant differences between regions

Source: Vertinsky et al. (1990).

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
British Columbia Ministry of Environment and Ministry of Forests (1983)	Reserving old growth timber stands to preserve deer and elk habitat on North Vancouver Island Examines five options differing in the amount of winter range provided for deer and elk.	Costs of providing winter ranges (foregone timber benefits) (1982$): $9.80/m^3$ stumpage $0.45/m^3$ annual rent $3.75/m^3$ wage cost $1.20/m^3$ corp. income tax $0.80/m^3$ logging taxes $16.00/m^3$ total 10% discount rate is used.	- calculate reduction in AAC(m^3) for each land use option. - multiply this value by the costs per m^3 to obtain annual costs of foregone timber harvests due to each option. -the $3.75/m^3$ wage cost is an estimate of the amount by which earnings in the forest sector exceed the opportunity cost of employing that labour. It is calculated by taking 15% of the wage in the manufacturing forest sector (given to be $25/m^3$). - calculates direct jobs lost for each option (no methodology given). Discounting: - break up future into two bits for benefits: the "present" (1982-2001), and the "future" (2001-2021), for the calculation of present value of benefits of hunting (ie. they discount only the "future" period). - to get the present value of costs, the usual discounting procedure is used (ie. on an annual basis).	- use computer simulations to project future deer populations and future timber harvests. - no attempt is made to value the loss of the right to secure tenure over harvesting timber stands. - does not calculate "shadow price" for foreign exchange earnings. A strange discounting procedure is used. Benefits are treated in a much more favourable way than costs are. In effect the first 20 years of benefits are not discounted at all. Only the years 2001-2021 are discounted back to 1982. Even so, they still arrive at a net present value of each option with costs strongly outweighing the benefits of habitat protection. Do not estimate the costs associated with the provision of forage areas.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
British Columbia Ministry of Forests, Strategic Studies Branch (1983)	Impact Analysis of the cost of establishing deer and elk reserves on TFL37 and 39	Direct economic cost of foregoing timber harvests (1982\$): \$120/m^3 is the value of shipments by forest industry 1973-81 avg wage and salary benefits are: \$15/m^3 logging \$27/m^{3}wood &paper &allied \$42/m^3. provincial government benefits: \$9.50/m^3 stumpage(1972-81 avg.) \$1.45/m^3 royalty(1979-82) \$6.70/m^3 TL stumpage & royalty (1977-81) \$0.33/m^3 annual rent \$0.80/m^3 logging tax(1972-82) \$1.20/m^3 corp inc tax (1971-79) \$1.10/m^3 social service tax (1971-79) \$2/m^3 personal inc tax (1971-79) \$0.60/m^3 social service tax on personal inc (1974-77) No discounting.	Employment effects are given by: 0.7 person-years(py) of direct employment in harvesting and managing TFL 37 for each 1000m^3 harvested (from Canadian Forest Products Ltd. 1972-81 avg). This number is also used for TFL 39. Statistics Canada data implies the following values for employment effects in other forest industries: sawmills and planing mills: 0.51py per 1000m^3 harvested on coast (1978-80 avg). plywood and veneer: 0.2py per 1000m^3 (1971-80 avg) pulp&paper: 0.4py per 1000m^3 (1971-80 avg) ⇒1.1 person-years of employment in wood processing for each 1000m^3 harvested on the coast. ⇒total direct employment in forest industries is 1.8py/1000m^{3}of timber harvested. Indirect and induced employment is 2 times direct employment.(from FCL Reed & Associates Ltd.,1975) The amount of timber harvest lost under each option is estimated to use with the above values in the calculation of the effects of each range reserve option.	Although indirect and induced employment effects are calculated, values are only given for direct employment effects in the analysis. (ie. they indicate the number of indirect and induced jobs lost but they are not included in the cost calculation) The analysis is only carried out for a "representative" year. There is no treatment of the time path of impacts. Contains no attempt to value non-market benefits or costs.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

MacMillan Bloedel (no date given - presumably 1983)	Response to MoE/MoF reports	They maintain that forestry values are understated. Forage area costs can and must be estimated. Costs associated with modifying current logging plans should be included. MB figures these additions would increase costs of foregone logging by 60% using the 10% discount rate. They take issue with the \$3.75/m^3 figure for the cost of foregone wage and salary benefits. Since wages are higher on the coast, a basic wage and salary cost of \$33.50/m^3 should be used. To this should be added employment benefits of 15% of wages and salaries. Therefore, the true manufacturing employment cost is \$5.78/m^3. They also maintain that logging employment costs should be included as any re-employment is likely to be at a lower wage. Thus, they get a total employment cost of \$9.18/m^3 instead of \$3.75/m^3 in B.C. MoE&MoF (1983) They feel that foreign exchange benefits of \$4.00/m^3 (MoF estimate) should be included. They suggest not discounting future net benefits. Instead just look at costs and benefits occurring in an average year.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
Bowden (1986)	Stein Valley, BC Examines two alternative developments: wilderness and mixed use.	Timber benefits (1986$): Revenue from timber: Lumber: Low $\$45/\text{m}^3$ Mid $\$51/\text{m}^3$ High $\$57/\text{m}^3$ Chips: $\$10/\text{m}^3$ Timber costs (1986$): Logging and hauling costs: $\$31.38/\text{m}^3$ Milling costs: $\$26.72/\text{m}^3$ Minstry of Forests costs: $1.00 per hectare of operable forest land. Harvests are assumed to be $110{,}000\text{m}^3$ /year.	High price of lumber taken from Gunton et. al.(1985). Low price is average of Gunton, et. als. low and medium prices. Medium price is the average of the resulting low and high prices. Chips price is taken from Gunton et. al.(1985). Logging, hauling and milling costs are weighted averages of the costs from BCFP(1986) and Lytton Lumber (1985). Ministry of Forest costs are variable costs only (related to the Stein) and exclude reforestation costs.(citation unclear)	In addition to the "basic" economic analysis (based on actual cash payments), Bowden discusses several economic adjustments. He does not actually apply these adjustments to his calculations. If unemployment exists, actual cash payments to labour exceed the opportunity cost of labour. Gunton et. al.(1985) calculates that inclusion of this effect would reduce PV of estimated costs by $4.9 million(at a 10% discount rate), which is quite significant depending on the price scenario. Can also "shadow price" foreign exchange earnings. Bowden provides a crude estimate of benefits to be 4% of foreign exchange earnings ($300,000/year). He mentions that by using the "AAC effect" harvest benefits may be treated as occuring in the present rather than when they actually occur. He mentions an employment multiplier of 3 and a GDP multiplier of 2.5-3. He also mentions government revenues of $\$1.60/\text{m}^3$ stumpage, $\$0.25/\text{m}^3$ annual rent for allocated AAC, and $\$2.00/\text{m}^3$ harvested personal income tax. He does not incorporate these values into his analysis.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
Pope (1986)	BC - West Coast Trail Wilderness vs mixed logging/wilderness uses.	Discount rate (R) is 8% (10% for sensitivity analysis) Wage differential, WD, is set equal to zero for the base case,and \$6.66/m^3 for sensitivity analysis. Timber harvest volume,VOL, equals 527m^3 /ha for coastal areas, and 681m^3 /ha for inland areas. Silviculture costs, SILV, are taken to be \$1106/ha all values in 1983\$ deflated with GNP price index.	Total timber benefits (TBT) are given by: $TBT= \sum_{T=1}^{50}(WD*VOL+STUMP)/(1+R)^T$ WD=\$/m^3 wage differential between forestry and all manufacturing sectors. WD is set to 0 for the base case and a sensitivity analysis is done with it set at \$6.66/m^3 The number is derived from average percentage wage differential over 1979-84 based on average weekly earnings for BC employees in the relevant sectors (from Statistics Canada). Using June 1983 weekly earnings and the 1977-81 average of 1.75 person-years per 1000m^3 harvested in coastal BC (BC MoF, Vancouver Region, 1985) she gets \$6.66/m^3 . STUMP=market value of timber(logs) less the cost of harvesting. Since this fluctuates a lot, she uses 10 year average (1974-83) of stumpage rates for various grades. VOL= scaled volume of timber harvested annually from the area Timber costs (those costs excluded from stumpage): $TCT= \sum_{T=1}^{50}(SILV*HA)/(1+R)^T$ SILV= average silvicultural costs per hectare. Derive this from average costs per hectare of each silvicultural activity for Vancouver Forest Region from Jones' (1983) compilation. Assumes 82% of land logged gets treated (from MB on TFL 44). For each treatment the degree to which it is used was calculated as a percentage of the total area surveyed from annual reports (BC MoF Vanc. Region, 1985). Assumes average silvicultural cost would apply to 1/50 of the area each year. HA= number of hectares logged annually.	She only examines market benefits and costs. Assumes silvicultural intensity will not change over the 50 year horizon.

Table 2: The Treatment of Timber Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values Used*	*Methodology*	*Comments*
SFU-NRM Report no. 6 (1990)	BC Calculates the effects of implementation of the Vahalla Society proposals for wilderness preservation	Fiscal Impacts: \$10.49/m^3 expected ten year average stumpage rate, coast \$8.38/m^3 expected ten year average stumpage rate, interior. Average provincial corporate income tax paid as a percentage of the net value of shipments (1979-86 avg): Logging 0.61% Wood Products 0.79% Paper&Allied 0.70% Effective sales tax rate on gross labour income = 1.8% Effective personal income tax rate on gross labour income = 6.94% All values are in 1988\$.	The value of forest products is calculated via a complicated formula. Forest industry expenditures are presented for aggregate categories (wages and salaries, fuel and electricity, and materials and supplies) Employment effects are also presented. They are derived from average annual income for workers in each sector divided by the projected decrease in wages and salaries expenditure to give the number of workers potentially affected. Multipliers are used to give indirect and induced employment effects. Stumpage calculation is given by: IR = BR + (VI - **VI**) IR=stumpage rate BR=base rate for coast or interior (set by provincial government) VI=value index for area being cut (difference between estimated selling price for the timber and the costs associated with bringing it to market) **VI** = mean value index for coast or interior (average of value indices for all timber harvested in a region over a given period of time). Disagregates corporate income tax data using method of Howard (1978).	Restrict fiscal analysis to provincial government revenues only, no attempt to quantify local government revenues. Assumes removal of lands from forest base results in an immediate reduction in AAC (ie. worst case scenario) No discounting of benefits or costs is done. They simply calculate impacts without regard to the point in time at which they occur. Non-fiscal impacts are presented in aggragate fashion only.
Heaps (1985)	*An Analysis of the Present Value of Stumpage under a Variety of Economic and Management Conditions*	5% discount rate in base case	Timber value: Calculates soil expectation value by: SE=(STUMP-STC)/(EXP(RxA)-1)-STC where A=rotation length, R=discount rate, STC=site treatment cost. STUMP=$(1+t)^{-1}$REV-COST is the Rothery formula. He maximizes this by choice of A. Assumes real revenues and costs are constant far into the future. This is a problem since the share of high value old logs will diminish as second growth timber is used.	This calculation is made in the context of deriving the optimal rotation length through maximization of soil expectation value.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies

Name	*Study Area*	*Values used*	*Source*	*Comments*
British Columbia Ministry of Environment and Ministry of Forests (1983)	B.C.- North Vancouver Island	Hunting benefits are: $27.50/hunter-day for deer $95.00/hunter-day for elk A threshold of 5 deer/sq.km is defined to be the recreationally useable population level (no source) Number of hunter days is found by multiplying the estimated annual harvest by the average hunter success rate which is: 12.5 hunter days/kill for deer (1976-81 avg) and 6.7 hunter days/kill for elk (1979-81 avg) Values are expressed in 1982 dollars. 10% discount rate is used.	Pearse-Bowden (1977) report (deer) McDaniels (1980) report (elk)	-use a wildlife model to estimate impact of various winter range programs on the number of deer and elk which can be maintained. This implies the level of hunting which can be maintained and, thus, the level of hunting benefits. - the threshold deer population requirement indicates the study is more of a cost-effectiveness one. -does not treat wolf predation effects and cost of wolf control. -does not treat effects on other wildlife species. - no attempt to measure option/existence benefits or non-consumptive use benefits. The authors mention that since they only measure direct consumptive use of the deer and elk that the benefits are understated. However, no attempt is made to state by how much they are understated and whether or not inclusion of other benefits could cause positive NPV of any reserves.
Bowden (1986)	B.C.- Stein Valley	Recreation values: $36.00/day for hunting $24.00 /day for fishing $5.00/day for day-hiking $15.00/day for backpacking and guided tours Measured in1986$ Uses 0, 8, 10% discount rates.	Gunton et al (1985) for values and activity levels for first three activities and the value of the fourth. Copeland (1985) for activity levels for backpacking and guided tours.	- costs of providing the recreational uses are omitted, rather than including an "arbitrary" cost estimate. - values come from Gunton et al and are regional averages of WTP. WTP is correct since recreation levels are not being realized at the present. (Gunton et. al. use willingness to sell determined by multiplying willingness to pay data by 3.25). - values are constant through time. -no attempt is made to quantify any redirection of recreation users from other areas to the Stein if the Wilderness option chosen. - indicates existence of a quality/accessibility tradeoff in estimating the value of the recreational opportunity (ie. logging roads allow access to remote areas). - referent group is taken to be the province of BC. It is assumed that all benefits from hunting and fishing accrue to BC residents and 80% of benefits from day hiking, backpacking and guided tours accrue to BC residents.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Pope (1986)	B.C. - West Coast Trail Three alternatives: Wilderness Multiple Use Logging	Recreation values: $45.44/day for wilderness hiking (wilderness alternative) $16.96/day for dispersed recreation (day-hiking - Multiple use alternative) $140,000/year cost to Parks Canada of operating West Coast Trail All values in 1983$ Uses 8, 10% discount rates.	U.S. Water Resources Council	- got value from WTP figures of U.S. Water Resources Council and multiplied them by 3.3 to get compensation demanded, which is used because the trail is already in use. - number of user days estimated from Parks Canada data (no particulars) - assumes that the growth in user days will be the same as BC population growth over the period 1981-2002. - no incorporation of carrying capacity (crowding effects may be important, especially to the Wilderness option). - no attempt is made to measure preservation value.
Phillips et. al. (1989)	Alberta - wildlife values	Consumptive recreation values: (benefits/person/year) $204.06 for big game hunting $151.12 for grizzly bear hunting All values in 1989$ Uses 5, 8% discount rates.	Contingent valuation study.	-the numbers represent average responses, but median responses are also calculated. The justification for the use of median values would be majority voting rules. -do not calculate non-consumptive benefits.
Pattison (1970)	Alberta - moose hunting	Consumptive recreation values: $4.13/person/day for residents $11.99/person/day for non-residents $5.45/person/day for all hunters	Contingent valuation 1968 data	-estimates daily and yearly Extra Market Benefits captured by resident and non-resident Alberta moose hunters using data from Big Game Zone 1 in northern Alberta.
Miller (1971)	Alberta - hunting	Consumptive recreation values: resident: $9.40/person/day in 1968 $8.33/person/day in 1969 non-resident: $18.04/person/day in 1968 $11.52/person/day in 1969	Contingent valuation 1968 data from 15 big game zones, 6 waterfowl zones and 5 upland bird zones	- "Extra Market Benefits" represent more than 75% of total social net benefits for resident hunters in this study.

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Prather (1974)	Alberta - hunting	Consumptive recreation values: CVM: $10.45/person/day for residents $16.08/person/day for non-residents TCM: $6.08/person/day for residents $16.80/person/day for non-residents	Contingent valuation and Travel cost studies 1969 data from 9 big game zones	-use data from 9 big game zones to infer benefits to Alberta hunters.
Phillips, DePape and Ewanyk (1977)	Alberta - total and Oil Sands Area - hunting	Consumptive recreation values: residents(nonresidents): $31.58(54.97)/person/day big game $21.60(38.68)/person/day bird game $33.24(48.48)/person/day all game	Contingent valuation 1976 data	
Adamowicz (1983)	Alberta - East Slopes - hunting	Consumptive recreation values: resident(nonresident) $72.94(246.53)/person/day mountain sheep $72.01(93.38)/person/day moose $70.48(116.67)/person/day grizzly bear $68.04(NA)/person/ day mountain goat $63(61.50)/person/day elk $53.20(37.08)/person/day black bear	Contingent valuation 1981 data	

Table 3: The Treatment of Recreation Values in Selected Forest Land Use Studies, cont'd

Name	*Study Area*	*Values used*	*Source*	*Comments*
Bodden and Lee (1986)	Alberta - resident pheasant hunting	Consumptive recreation values: CVM: $17.44/person/day TCM: $25.37/person/day	Contingent valuation and Travel cost 1985 data from south Alberta	
Heaps (1985)	Selected parks in B.C. - Alice lake - Cultus lake - Mount Seymour - Cypress Bowl	$4 mean social value per user day of recreation. Measured in 1979$ 5% discount rate used in base case	Griffen (1984) derives social value of recreation from estimated demand functions for recreation days for 3 of these parks.	Examines a way to allow for non-timber benefits in the maximization of stumpage (or calculation of optimal rotations). He found a weight for wilderness values such that maximum timber plus non-timber values required a rotation period of at least 100 years. This implies non-timber value of $400/yr/ha for a 100 year old stand. This provides a threshold level of non-timber benefits above which the forest stand should not be logged. From parks data he calculates visits/hectare/year for four parks. Using Griffen's value per day number he derives social values of recreation per hectare per year: Alice Lake $1000 Cultus Lake $1160 Mount Seymour $220 Cypress Bowl $600 Thus, Alice Lake, Cultus Lake and Cypress Bowl should be kept as parks. If visual aesthetic values are included, Mount Seymour would probably make the scratch also.

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making

Discount Rate	*Particulars*
0%	The idea of forest rent as used in 18th century Europe as the basis for tax collection did not consider any interest on the capital embodied in the forest (Gane, 1968). The idea was later reintroduced by Shepard(1925).
3%	This "real" interest rate is used by Hynard(1986). It corresponds to the long-term difference between market interest rates and inflation.
3%	This is based on a study of the real rate of return on long-term Government of Canada bonds by Reuber and Wonnacott (1961). This same figure was found for the period 1956-1977 in a Wood Gundy study (1977).
3%,5%,8%	These values are used in the benefit/cost analyses of Ontario reforestation investment by Anderson (1979).
4%	This value was used by von Gehren (1849) and Faustman (1849) in their model of discounted cash flow for forest lands.
4%	U.S. Forest Service's recommended rate based on work by Row, et. al. (1981).
5%,10%,15%	This is the range of values suggested by Canadian Federal Treasury Board Guidelines (1976)
6%	During 1956-73 this figure was the average expected real yield on Canadian equities traded on the Toronto Stock Exchange (Wood Gundy, 1977)
6%	This is the return, before tax and after inflation, on a diversified portfolio of stocks between 1871 and 1973 (Bernstein 1974)
6%	This is the real historical return, after tax and after inflation, on corporate capital (Nordhaus 1974)
7-8%	In the period 1973-1976 expected real yields on Canadian equities increased to this level (Wood Gundy 1977). The real supply price of capital in Canada was in this range during 1955-1972 (Helliwell et. al.1973)

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

7-15%	Mishan (1976) argues that the discount rate should reflect only the highest rates of return on private investment.
8%, 10%, 12%	Recommended rate for B.C. cost benefit analysis from the Environmental and Land Use Committee Secretariat (Loose ((1977)).
9.5%	This is the average overall rate of return on private investment in the Canadian economy. This figure is the result of an empirical study by Jenkins (1972) of the financial statements of numerous Canadian industries during 1965-1969. This number is what promted Treasury boards across Canada to choose 10% for use as the social discount rate. The following four studies represent reactions/alternatives to Jenkins' approach.
7%	Burgess (1981) argues that the elasticities used by Jenkins to weight the various industries were incorrect. The 7% number comes from using Jenkins' model with the "correct" elasticities.
6.5%	Boadway et. al. (1984) estimate social discount rate based on rates of return in financial markets instead of accounting data. They also incorporate various taxes. They use data for the period 1963-1971.
6.6%	Spiro (1987) modified Boadway et. al. to get this number. He modified it by incorporating more tax effects.
3-5%	Heaps and Pratt (1989) make some adjustments to above calculations. They argue that a risk-free rate should be used. Risk and uncertainty should be treated directly using Expected Net Present Value. Also note that estimates of consumption rate of interest is around 3% which then forms a lower bound on the social discount rate.

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

Specifically applied to forestry

Name	*Study*	*Methology*	*Comments*
British columbia Ministry of Environment and Ministry of Forests (1983)	Reserving old growth timber stands to preserve deer and elk habitat on North Vancouver Island Examines five options differing in the amount of winter range provided for deer and elk.	Discounting: - break up future into two bits: the "present" (1982-2001), and the "future" (2001-2021), for the calculation of present value of benefits of hunting (ie. they discount only the "future" period). - to get PV of costs, the usual discounting procedure is used (ie. on an annual basis).	Benefits are treated in a much more favourable way than costs are. In effect the first 20 years of benefits are not discounted at all. Only the years 2001-2021 are discounted back to 1982. Even so, they still arrive at a net present value of each option with costs strongly outweighing the benefits of habitat protection.
British Columbia Ministry of Forests, Strategic Studies Branch (1983)	Impact analysis of the cost of establishing deer and elk reserves on TFL37 and 39	No discounting done. Impact analysis only, ie. they only look at impacts per volume of wood harvest lost.	
MacMillan Bloedel (1983)	Response to MoF and MoE&MoF studies	"The problems associated with selection of and acceptable discount rate and the failure to clearly present the costs and benefits that are incurred each year necessitate an alternative way of presenting the values. A suggested method is to view the costs and benefits that will occur in an average year." (p. 20) They use average hunter days per year and volume in m^3 of foregone timber harvest multiplied by their average unit values to get net benefits for each alternative in a representative year.	
Pope (1986)	BC West Coast Trail	Uses discount rate of 8%, 10% used for sensitivity analysis, following the recommendations of Loose (1977) in Guidelines for Cost-Benefit Analysis. The rate is used to discount total net benefits from timber harvesting, and silvicultural costs (separately), assuming silvicultural insensity will not change over the 50 year time horizon.	

Table 4: Adjusting for the Timing of Benefits and Costs in Social Decision Making, cont'd

Name	*Study*	*Methology*	*Comments*
Heaps (1985)	*An Analysis of the Present Value of Stumpage under a Variety of Economic and Management Conditions*	Uses a 5% discount rate in the calculation of soil expectation values. To get this number he follows methodology recommended in Row et al (1981) which underlies the US Forest Service's recommended rate of 4%. His view is that discount rates used in forestry investment analysis should reflect risks associated with forestry. These risks are quite low when diversified over a large number of stands. Thus, he accepts the calculation of Row et al (1981) and rejects that of Jenkins (1980) which recommends 10% discount rate for public projects in Canada He calculates his 5% rate by using the average rate of return on AAA corporate bonds (believed to be relatively risk-free) with an upward adjustment to reflect loss of taxes from the foregone private investment.	
Bowden (1986)	Development alternatives for the Stein Valley in BC	Uses discount rates of 8%, 10% (and 0% for "illustrative" purposes) to discount net benefits of the alterative developments. No comment is made as to where these came from. Values used for wilderness uses are assumed constant through time.	
Loose (1977)	*Guidelines for Cost-Benefit Analysis* (B.C. Environmental and Land Use Committee Secretariat guidlines)	The correct measure to use is the social opportunity cost of capital. Two parts to guideline for discount rates: (i) Use a weighted average private sector rate of return where the weights are the proportions of total financing for the project which are diverted from each sector of the economy (the province in this case). Find out the proportion of funds diverted from other potential investments in given sectors within the province and use these to weight the rates of return calculated by Jenkins (1972) for Canada. (ii) If sectoral detail cannot be obtained, should use 10%, with 8% and 12% used for sensitivity analysis (if desired).	In choosing the opportunity cost of capital as the correct concept he cites the following problems with the social rate of time preference idea: - the degree to which intergenerational efficiency should govern public policy cannot even be determined at the political level. - politicians elected by the present members of society cannot determine what is best for future generations. - nor can politicians determine what future generations want without knowledge of their aggregate individual preference functions. Therefore, for practical reasons, analysis must proceed largely on the assumption that economic efficiency is the primary basis for the deterimation of the discount rate.

A REVIEW OF THE BRITISH COLUMBIA CROWN LAND ALLOCATION AND MANAGEMENT PLANNING PROCESS

A BACKGROUND PAPER PREPARED FOR THE BRITISH COLUMBIA
FOREST RESOURCES COMMISSION

By: Dorli M. Duffy

School of Community and Regional Planning
University of British Columbia

October 1990

A REVIEW OF THE BRITISH COLUMBIA FOREST LAND ALLOCATION AND MANAGEMENT PLANNING PROCESS

List of Figures iii

List of Abbreviations iv

1.0 INTRODUCTION 1

2.0 HISTORY - Crown land planning and allocation in B.C. 3

2.1 1945-1969 Multi-Purpose Agency 4
    2.1.1 Land allocation and management 4
    2.1.2 Forestry 6
2.2 1971-1979 Inter Agency 8
    2.2.1 Land allocation and management 8
    2.2.2 Forestry 13

3.0 CURRENT B.C. CROWN LAND PLANNING PROCESS 15

3.1 Ministry of Forests 21
    3.1.1 Legislative Mandate 21
    3.1.2 Organizational Structure 25
    3.1.3 Planning Process 28
        3.1.3.1 Provincial Planning 32
        3.1.3.2 Regional Priorities 33
        3.1.3.3 Forest Management Planning 34
        3.1.3.4 Local Resource Use Planning 42
        3.1.3.5 Resource Development Planning 44

3.2 Ministry of Crown Lands 46
    3.2.1 Legislative Mandate 46
    3.2.2 Organizational Structure 46
    3.2.3 Planning Process 46

3.3 Ministry of Parks 48
    3.3.1 Legislative Mandate 48
    3.3.2 Organizational Structure 51
    3.3.3 Planning Process 52
        3.3.3.1 The Allocation Planning Process 52
        3.3.3.2 Park Management Plans 54

3.4 Ministry of Environment 56
    3.4.1 Legislative Mandate 56
    3.4.2 Organizational Structure 58
    3.4.3 Planning Process 58

3.5 Ministry of Energy, Mines and Petroleum Resources 60
  3.5.1 Organizational Structure 60
  3.5.2 Planning Process 61
    3.5.2.1 Guidelines for Mineral Exploration 61
    3.5.2.2 Mine Development Review Process 63

3.6 Other Bodies 68
  3.6.1 Environment and Land Use Committee 68
  3.6.2 Cabinet Committee on Sustainable Development 69
  3.6.3 B.C. Utilities Commission 70
  3.6.4 Agricultural Land Commission 74
    3.6.4.1 Legislation and Mandate 74
    3.6.4.2 Planning Process 75
  3.6.5 Major Project Review Process 78

4.0 CONCLUSIONS 82

REFERENCES 83

Appendix 1
  Technical methods used in forest resource management planning.

LIST OF FIGURES

Page

Figure 1. Land Use Planning in British Columbia (1976) 11

Figure 2. British Columbia Land Ownership and Crown Land Jurisdictions 17

Figure 3. British Columbia Crown Land Planning 19

Figure 4. Organization of the Ministry of Forests 26

Figure 5. Forest Planning Framework 29

Figure 6. Summary of Ministry of Forests Plans 30

Figure 7. Timber Supply Area Planning Process 36

Figure 8. Tree Farm License Management and Working Plan Process 37

Figure 9. Mine Development Review Process (MDRP) 65

Figure 10. Energy Project Review Process (EPRP) 72

Figure 11. Major Project Review Process (MPRP) 80

Appendix 1

Figure 12. Matrices used in Timber Supply Analysis System (TSAS) 90

Figure 13. A Framework for Integrated Resource Management (AFIRM) 93

LIST OF ABBREVIATIONS

AAC - Allowable Annual Cut
AFIRM - A Framework for Integrated Resource Management
ALC - Agricultural Land Commission
ALR - Agricultural Land Reserve
BCUC - British Columbia Utilities Commission
CCED - Cabinet Committee on Economic Development
CCSD - Cabinet Committee on Sustainable Development
ELUC - Environment and Land Use Committee
EPRP - Energy Project Review Process
LRUP - Local Resource Use Plan
MDRP - Mine Development Review Process
MDSC - Mine Development Steering Committee
MEMPR - Ministry of Energy, Mines and Petroleum Resources
MoCL - Ministry of Crown Lands
MoE - Ministry of Environment
MoF - Ministry of Forests
MoP - Ministry of Parks
MoRED - Ministry of Regional Economic Development
MPRP - Major Project Review Process
PSYU - Public Sustained Yield Unit
RRMC - Regional Resource Management Committee
TFL - Tree Farm License
TFL M&WP - Tree Farm License Management and Working Plan
TSA - Timber Supply Area

A REVIEW OF THE BRITISH COLUMBIA CROWN LAND ALLOCATION AND MANAGEMENT PLANNING PROCESS

1.0 INTRODUCTION

Much of British Columbia's rich endowment of natural resources remains under provincial jurisdiction. To date, roughly 92% of the province has been retained as Crown land. As a result, the provincial government has significant responsibility for the allocation and management of these resources.

The purpose of this paper is to review the current institutional system for allocating and managing Crown lands in British Columbia (B.C.). As a reference document to a larger set of analytical papers, this report is strictly descriptive in nature. In this paper, the role of the provincial agencies engaged in land allocation and management are outlined and the pertinent legislation is identified.

The format of this paper is as follows. Section 2 presents an historical review of institutional mechanisms employed in Crown land planning in B.C., and provides a context for a discussion of the current institutional structure in the third section. Section 3 offers a review of the relevant legislative mandates, organizational structures and planning processes of agencies involved in the administration of Crown land.

Information for this report has been drawn from government policy and planning documents, and from semi-structured interviews with government staff. The author gratefully acknowledges the work of Kim Brenneis, John Fox, and Wayne Clissold-Hoyle of Simon Fraser University which contributed substantially to this report.

Currently, the Ministry of Forests administers approximately 85% of the provincial land base--those lands designated as provincial forests. It is clear that with such a large proportion of the Provincial land base under jurisdiction of the Ministry of Forests (MoF), the discussion will focus particularly on this Ministry's policies and structure.

2.0 **HISTORY** - Crown land planning and allocation in B.C.

The evolution of Crown land planning in B.C. since the Second World War can be divided into three phases, characterized by the following types of administration: a Multi-Purpose Agency, Inter-Agency Coordination and a Dominant Purpose Agency. Major events in this evolution are summarized below in a chronological summary of institutional changes affecting Crown land allocation and management from World War II to the present. Following this summary, the first two phases are briefly discussed. The current phase, characterized by a dominant agency, is described in Section 3 of this paper.

First Phase - Multi-Purpose Agency

1948-67	British Columbia Natural Resources Conference
1965	*Park Act* passed
1968	First Regional Districts established
1968	Technical Planning Committees established
1969	Ad-hoc Land Use Committee of Cabinet formed

Second Phase - Inter-Agency Coordination

1971	*Environment and Land Use Act* passed
1971	Environment and Land Use Committee formed
1971	*Ecological Reserves Act* passed
1973	ELUC Secretariat formed
1975	Department of Environment created
1975	Department of Forests established
1975	Royal Commission on Forestry initiated
1975	Resource Management Regions established
1976	Cabinet Committee on Economic Development formed
1977	Ministry of Environment established; ELUC Secretariat administratively absorbed
1977-78	Regional Resource Management Committees established
1978	New *Forest Act* passed

Current Phase - Dominant Purpose Agency

1980	ELUC Secretariat dissolved; staff dispersed
1983	Regional Resource Management Committees abolished
1983	Regional Districts stripped of planning responsibilities
1983	Resource Management Regions reduced from eight to five
1983	Resource ministries staff reduced 30-40% under "restraint" program
1986	Integrated Resources Branch formed in Ministry of Forests
1990	Cabinet Committee on Sustainable Development formed through the amalgamation of ELUC and the Cabinet Committee on Economic Development

Forestry has emerged over this century as the major activity occurring on Crown lands. For this reason, in the discussion of each phase, general developments in Crown land administration are dealt with separately from developments occurring in forest land allocation and management.

2.1 1945-1969 Multi-Purpose Agency Phase

Prior to the 1970s, planning and management in British Columbia was dominated by a multi-purpose agency, the Ministry of Lands, Forests and Water Resources.

2.1.1 Land Allocation and Management

Under the Land Act, the Ministry of Lands, Forests and Water Resources had legislative responsibility for much of the Provincial land base from 1945 -1969. Land parcels were allocated and reviewed on an ad-hoc basis by interested ministries rather than using a special planning process to achieve an overall "systems plan".

Prior to 1950 and the formation of the Department of Recreation and Conservation, creation of provincial parks was also within the mandate of the Ministry of Lands, Forests and Water Resources. Early parks were established to encourage tourism and later, to meet public demand for recreation. In 1965, the Department of Recreation and Conservation's mandate was strengthened with the passage of the Park Act which added a strong conservation mandate to its traditional emphasis on tourism and recreation.

Before the early 1960s, provincial resource inventories were limited in many sectors and the abundance and types of resources throughout B.C. were poorly documented. Resource surveys initiated in the 1960s to address this deficiency included the Canada Land Inventory which provided important data for provincial natural resource assessments.

Land and resource allocation prior to the 1970s occurred primarily in response to proposals from interested agencies and the private sector. The referral process was the main decision tool used to provide resource agencies with the opportunity to comment on development proposals from other agencies. Analysis was not generally incorporated in this process, due primarily to time constraints. Rather, opposing agencies worked towards compromise which permitted development, but with less damage on other resources (O'Riordan 1976). Integrated planning emerged later in the 1960s with the use of tools such as folio planning in which map overlays were used to assess relative land values.

2.1.2 Forestry

Forestry in B.C. underwent substantial growth between 1945 and 1970. While a burgeoning provincial industry was emerging, the 1945 Sloan Commission of Inquiry was formed to address the problem of improving forest management. The subsequent Sloan report resulted in an amended Forest Act in 1947 calling for the adoption of a sustained yield management approach. Sloan also suggested that the province's forest lands be organized into "sustained yield units;" areas regulated to provide timber to nearby mills for an indefinite period (BC MoF 1987). The amended Forest Act created two kinds of forest management units--Tree Farm Licenses (TFLs) and Public Sustained Yield Units (PSYUs). Tree Farm Licenses were designed

> to promote the orderly development and careful management of Crown and private land holdings, and to encourage industrial development and community stability by providing long-term supplies of timber from existing or proposed utilization plants (Pearse 1976).

Today, TFLs and Timber Supply Areas (which replaced PSYUs) continue to be the main forest management units in British Columbia. TFLs are relatively long term tenure agreements between the provincial government and major forest products firms which provide responsibilities for forest management within a specified area. TFLs are area-based tenures that grant rights to licensees to manage forest resources according to a Management and Working Plan prepared by the licensee and approved periodically by the Chief Forester of the MoF. Each license has a term of twenty-five years with an opportunity for replacement once every ten years. While licensees are responsible for the management of lands under TFLs and for the preparation of strategic plans, the Forest Service retains the responsibility for approving such plans.

Public Sustained Yield Units (PSYUs) were parcels of Crown forest land managed by the Forest Service to meet the needs of smaller enterprises, or to provide timber where area-based licenses were considered inappropriate (Niezen 1989). Most PSYUs have since been incorporated into the current Timber Supply Areas (TSAs) which are geographic land units. TSA boundaries now closely follow those of forest districts.

With the exception of TFLs, all other forms of tenure remain in TSAs. Other current forms of tenure include Forest Licenses, Timber Sale Licenses, Pulpwood Agreements and Woodlot Licenses. TSAs are managed using a system of volume-based licenses. In doing so, the provincial government retains the flexibility to adjust existing licence areas, and to open additional areas for new licenses (Niezen 1989). Distribution of tenures and timber volumes to various sectors of the industry is based on an apportionment plan prepared by the government which outlines Allowable Annual Cut (AAC) levels.

Summary: The Multi-Purpose Agency Phase was dominated by the Ministry of Lands, Forests and Water Resources. Developments during this period included improved resource inventories, a broader Parks mandate, and ad-hoc resource and allocation decisions using referral processes.

Developments in forestry included an amended Forest Act which established sustained yield management and the forest management units which continue to dominate today.

2.2 1971-1979 Inter-Agency Phase

Overlapping jurisdictions, vested interests and the absence of reliable information and problem-solving forums contributed to increased conflict in the late 1960s. Partly in response to these difficulties in coordinating planning, the Environment and Land Use Committee of Cabinet (ELUC) was formed in 1971. During the 1970s, planning was greatly influenced by ensuing efforts to integrate planning through ELUC and other institutional arrangements. As a result, this phase is characterized by "inter-agency" coordination.

2.2.1 Land Allocation and Management

In 1969, an informal committee of Cabinet Ministers was established to resolve resource conflicts: the Land Use Committee. The Environment and Land Use Committee (ELUC) was formally established in 1971 and the ELUC Secretariat was formed in 1973. ELUC was formed as a standing committee of Cabinet "representing a range of environmental, conservation, resource development and social service agencies" (O'Riordan 1987). Empowered by the "notwithstanding clause" within the Environment and Land Use Act (ELU Act), ELUC was given legislated precedence over other departments, thereby allowing the integration of multiple objectives in land allocation. The power of this Act lay in its supremacy over all previous acts and regulations.

Under the ELU Act, duties of the ELUC were:

- to establish and recommend programs designed to foster increased public concern about, and awareness of, the environment;
- to ensure that all the aspects of preservation and maintenance of the natural environment are fully considered in the administration of land use and resource development commensurate with maximum beneficial land use, and to minimize and prevent waste of such resources, and despoilation of the environment occasioned thereby;
- if considered advisable, to make recommendations to the Lieutenant-Governor in Council respecting any matter relating to the environment and the development and use of land and other natural resources;
- to inquire into and study any matter pertaining to the environment, or land use; and
- to prepare reports and, if advisable, make recommendations for submission to the Lieutenant-Governor in Council (Ward 1976).

The ELUC Secretariat, composed of three units--Resource Analysis, Resource Planning and Special Projects--coordinated interaction between the various agencies involved in land allocation, and provided input from affected agencies not otherwise directly involved in individual proposals. During its life, the Secretariat developed numerous guidelines and procedures including formal procedures for environmental impact assessments of mines, energy projects, highways and other linear developments, and provincial guidelines for benefit-cost analysis of resource use decisions.

Two reviews of Canada's land management and programs in the 1970s (Macenko and Neimanis 1983 and Ward 1976) provide comprehensive accounts of British Columbia's institutional system during this period.

Macenko and Neimanis distinguish between the central review role of Provincial Cabinet and its committees, and interdepartmental mechanisms supporting these Cabinet Committees (see Figure 1).

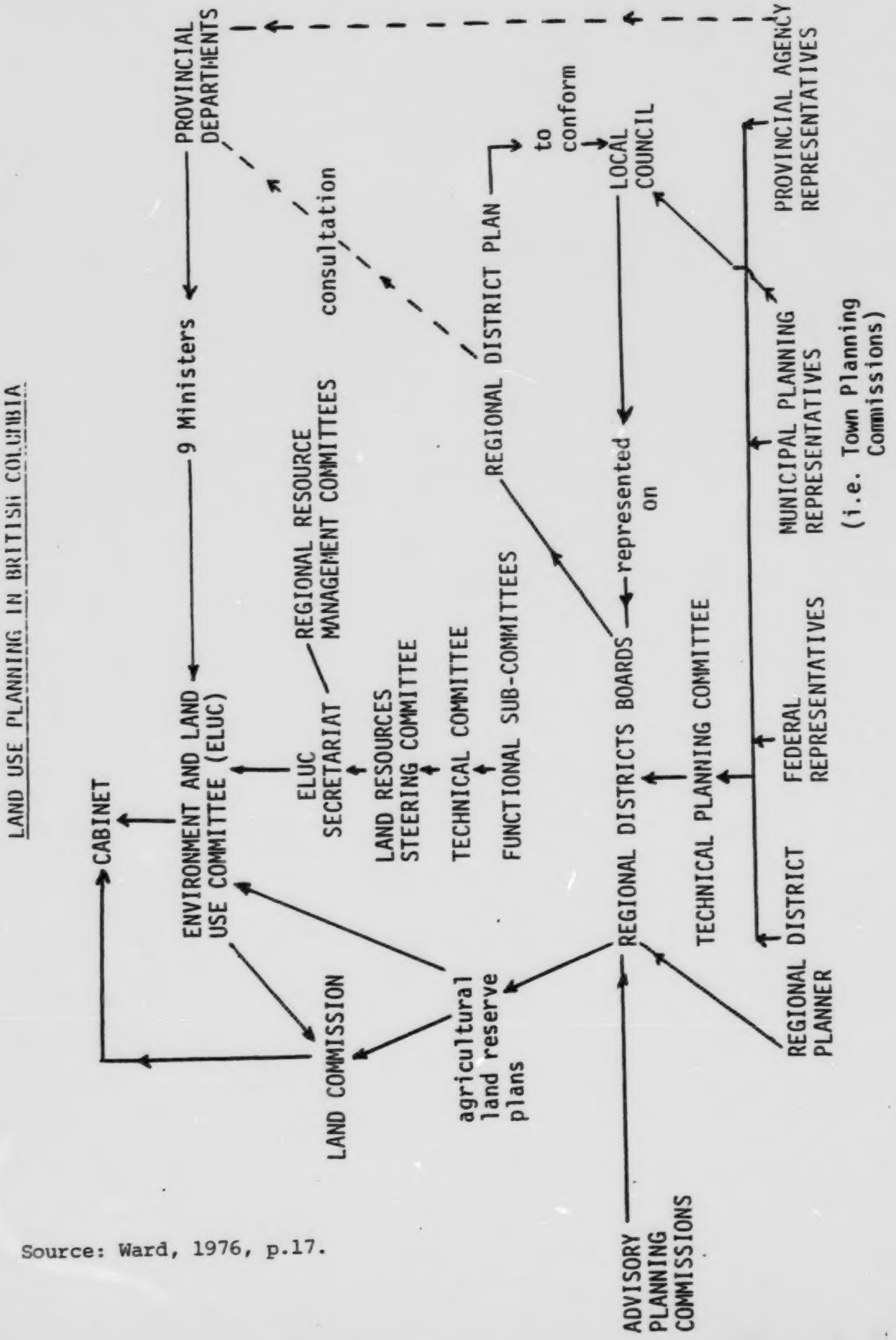
The central review agency for land transactions in B.C. during the 1970s was the Provincial Cabinet functioning through three Cabinet Committees: ELUC, the Cabinet Committee on Economic Development (CCED) and Treasury Board. Initial allocation of Crown land occurred through the Ministry of Lands, Parks and Housing under policies approved by the Minister, Cabinet Committee or Cabinet. Land required for industrial purposes was conveyed to the B.C. Development Corporation which arranged for the details of disposition under policy guidance from the CCED. The Cabinet Committee on Economic Development (CCED) was formed in 1976 to foster coordination between ministries concerned with development issues. Cabinet Committees met regularly to conduct formal reviews of referred matters, resolve land use conflicts, and give direction on major land resource commitments[1].

In addition to the central review mechanisms outlined above, Cabinet Committees were supported by interdepartmental mechanisms including the advisory technical committee of Deputy Ministers and Regional Resource Management Committees (RRMCs). Established in 1978, RRMCs were comprised of senior regional resource agency officials and served as

---

[1] Cabinet Committees were comprised of Ministers with responsibilities related to the land transactions under consideration. These committees were minimally staffed and assisted by support work performed by Ministries and Crown agencies.

Figure 1. Land Use Planning in British Columbia (1976)


LAND USE PLANNING IN BRITISH COLUMBIA
CABINET
ENVIRONMENT AND LAND USE COMMITTEE (ELUC)
9 Ministers
PROVINCIAL DEPARTMENTS
LAND COMMISSION
ELUC SECRETARIAT
REGIONAL RESOURCE MANAGEMENT COMMITTEES
LAND RESOURCES STEERING COMMITTEE
TECHNICAL COMMITTEE
FUNCTIONAL SUB-COMMITTEES
consultation
agricultural land reserve plans
REGIONAL DISTRICT PLAN
to conform
LOCAL COUNCIL
REGIONAL DISTRICTS BOARDS
represented on
ADVISORY PLANNING COMMISSIONS
TECHNICAL PLANNING COMMITTEE
REGIONAL PLANNER
REGIONAL DISTRICT
FEDERAL REPRESENTATIVES
MUNICIPAL PLANNING REPRESENTATIVES
(i.e. Town Planning Commissions)
PROVINCIAL AGENCY REPRESENTATIVES

Source: Ward, 1976, p.17.

decentralized mechanisms to coordinate proposal reviews and approvals, and agency interests in land transactions. RRMCs also served a primary role for interagency communication and conflict resolution (Heayn 1977, Ward 1976). Evaluations of proposals and decisions on non-contentious issues were undertaken at the regional level with interagency coordination facilitated through the RRMCs. Alternatively, areas of conflict were often referred to the ELUC Secretariat for analysis and to ELUC and Cabinet for resolution when necessary.

Regional Resource Management Committees were a focal point for the institutional changes that took place during this phase. Through these committees, integrated resource management was formalized and diffused. For example, RRMCs were given responsibility for preparing integrated resource management plans for sub-regions within their jurisdiction (Heayn 1977).

In addition to the RRMCs, each Ministry also maintained an "Executive Committee" that coordinated activities of respective Ministries in fulfilling their mandates. Executive Committees membership included Deputy Ministers and Assistant Deputy Ministers. Executive Committees and RRMCs met on a regular basis and attempted to reach decisions by consensus (Macenko and Neimanis 1983).

Other agencies with jurisdiction over Crown lands at that time were the Departments of Environment (DoE) and Forests, both created in 1975, and the Provincial Parks Branch (Ward 1976). Under the Land Act and within the DoE, the B.C. Land Service had jurisdiction over 30 to 40 per cent of provincial Crown lands; those lands that were considered "vacant" or had been Crown-leased.

Once formed, the Department of Forests retained sole responsibility for administration of Crown timber under the Forest Act, and legal jurisdiction over more than 50 per cent of the province (Ward 1976). This was the beginning of the end of the Inter-Agency Phase and initiated the progression towards the present Dominant Purpose Agency. The DoE was renamed the Ministry of Environment in 1977 and the Ministry of Forests was formally created in 1978.

The Parks Branch role grew during the 1970s and, in 1971, B.C. became the first province to establish ecological reserves under the Ecological Reserves Act. Together with a strengthened Park Act in 1978, the Ecological Reserves Act provided the Parks Branch with increased control over its land base. While early parks had been established to meet tourism and recreation demands, the new Park Act added a strong conservation mandate.

2.2.2 Forestry

Until 1978, Crown land allocation and some management responsibilities lay with the Ministry of Lands, Forests and Water Resources. The Ministry of Forests Act of 1978 established the Ministry of Forests and assigned it responsibility for planning and managing lands designated as provincial forests. This action diminished the role and power of

ELUC by placing the vast majority of Crown lands under the jurisdiction of the Ministry of Forests.

The Pearse Commission of 1976 paved way for further revisions to the Forest Act in 1978, including provisions for the designation of Crown lands as provincial forests, setting of harvest rates, conversion of PSYUs to Timber Supply Areas (TSAs), establishment of the Small Business Enterprise Program (SBEP), and creation of Timber Sale and Woodlot Licenses.

Summary: Prior to the enactment of the Ministry of Forests Act in 1978, planning during this phase was highly integrated. ELUC was the major policy development and inter-agency coordination vehicle and RRMCs provided coordination at the regional level. Integrated resource management was initiated and diffused through these central and regional mechanisms. Products of this phase include guidelines for benefit-cost analysis and procedures for environmental impact assessment developed by the ELUC Secretariat. This phase also saw the creation of the Ministry of Environment and the Ministry of Forests.

3.0 CURRENT B.C. CROWN LAND PLANNING PROCESS

This section reviews the recent evolution of Crown land administration and provides a detailed discussion of the legislative mandates, organizational structures and planning processes of agencies involved in Crown land allocation and management.

1980-present Dominant Purpose Agency Phase

Throughout the past decade most of the integration efforts developed in the 1970s have been dismantled and replaced by one dominant purpose agency: the Ministry of Forests. Much of this dismantling occurred in response to government restraint and down-sizing through the recession. During this time, RRMCs were abolished in 1983, Regional Districts were stripped of planning responsibilities, the number of Resource Management Regions was reduced from eight to five, and resource ministry staffing was cut by approximately 30-40 per cent. With the dismantling of RRMCs, the Ministry of Forests' leadership became more pronounced while creating a vacuum at the regional level with respect to coordination of resource management programs and integrated resource management.

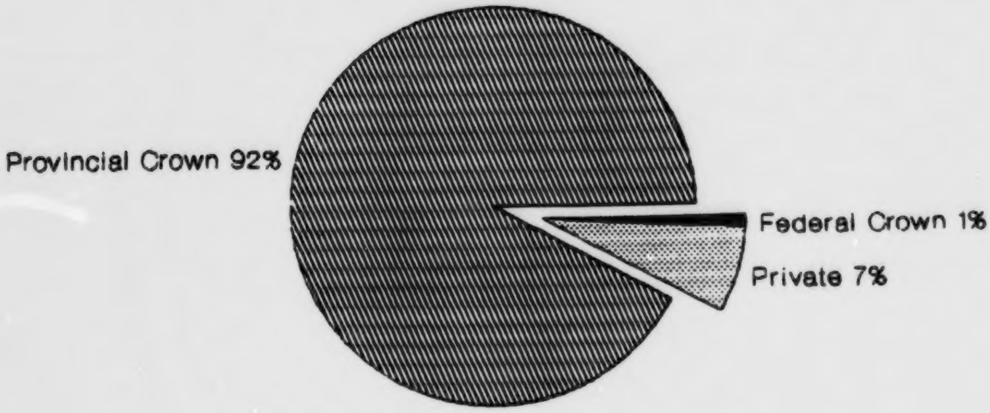
The ELUC Secretariat was dissolved in September 1980 and its staff was distributed to other ministries. The Ministry of Intergovernmental Relations now serves as secretary to ELUC which continues to handle such matters as appeals from the Agricultural Land Commission. ELUC's former role in policy development and inter-ministry coordination is performed to some degree by its successor, the Cabinet Committee on Sustainable Development created in 1990 through the amalgamation of ELUC and the Cabinet Committee on Economic Development.

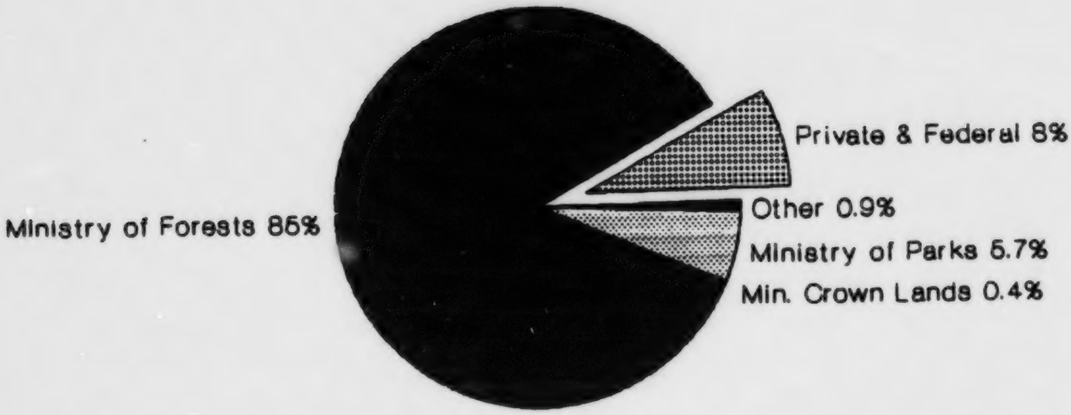
Today the Ministry of Crown Lands and the Ministry of Environment continue to manage their reduced land bases and provide procedural approval of other departmental decisions, but have very limited roles in provincial land allocation. The Ministry of Forests presently controls the bulk (85%) of the land base (see Figure 2).

The current phase commenced with enactment of the Ministry of Forests Act (MoF Act) and the Forest Act in 1978. The MoF Act places renewed emphasis on resource management and requires periodic reviews of Ministry programs, including a Ten Year Forest and Range Resource Analysis and a Five Year Forest and Range Resource Program. Greater recognition has also been given to strategic supply and demand analysis. Requirements for Timber Supply Area planning began in earnest during the 1980s with implementation of sustained yield and integrated resource management policies for provincial forests.

Additional amendments have been made to the Forest Act. In 1987 the Forest Act was amended to recognise wilderness as a resource in provincial forests. This amendment gave the Ministry of Forests the responsibility to consider wilderness in integrated resource management planning. More recently, in July of 1990, the Ministry of Forests adopted an Integrated Resource Planning Policy and an Integrated

Figure 2. British Columbia Land Ownership and Crown Land Jurisdictions


British Columbia Land Ownership - 1989


B.C. Crown Land Jurisdictions

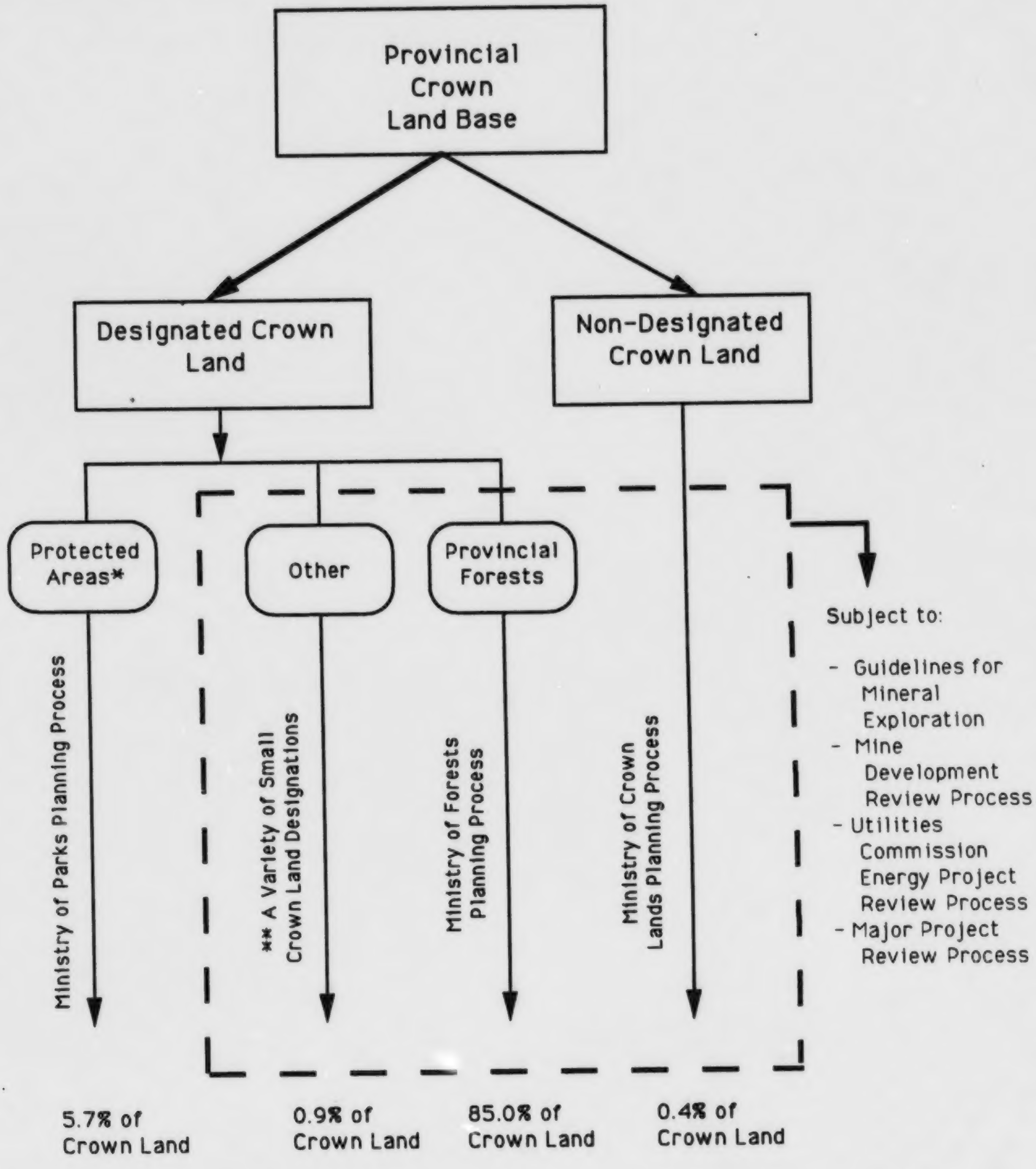
(Source: BC MoCL 1989a)

Resource Management Policy for management on provincial forests. These policies provide a definition of integrated resource management and clarify principles and procedures for its implementation.

Currently, the main agencies which administer the allocation and management of provincial Crown lands include the Ministry of Forests (MoF), the Ministry of Crown Lands, Ministry of Parks, Ministry of Environment and the Ministry of Energy, Mines and Petroleum Resources. Other ministries are consulted or become active participants when planning for resource development requires their input. In addition, a number of review processes and Commissions have overriding authority for specific land uses. Contentious resource issues are elevated to the political level where the Cabinet Committee on Sustainable Development and the full Cabinet adjudicates the process. The institutional structure for planning and allocation of Crown lands in B.C. is displayed in Figure 3.

Jurisdiction or management authority for Provincial Crown lands depends on how the land has been designated. Cabinet is responsible for designating Crown lands for specific uses, subject to statutes approved and enacted by the Legislature, and for establishing broader policies and programs. In addition, the Cabinet Committee on Sustainable Development is responsible for resolving land use conflicts. At the Ministry level of land use planning, consideration for different land and resource uses is conducted through inter-

Figure 3.
British Columbia Crown Land Planning


Provincial Crown Land Base
Designated Crown Land
Non-Designated Crown Land
Protected Areas*
Other
Provincial Forests
Ministry of Parks Planning Process
** A Variety of Small Crown Land Designations
Ministry of Forests Planning Process
Ministry of Crown Lands Planning Process
Subject to:
- Guidelines for Mineral Exploration
- Mine Development Review Process
- Utilities Commission Energy Project Review Process
- Major Project Review Process
5.7% of Crown Land
0.9% of Crown Land
85.0% of Crown Land
0.4% of Crown Land

* Protected Areas include Parks and Ecological Reserves
** Includes Ministry of Highways, etc.

ministerial referral processes such as those for Timber Supply Area (TSA) plans.

Each of the main agencies which administer the allocation and management of Crown lands are reviewed in the following sections.

3.1 MINISTRY OF FORESTS

3.1.1 Legislative Mandate

The Ministry of Forests is the primary Ministry responsible for Crown land use planning in B.C. and operates under three interlocking pieces of legislation: the Ministry of Forests Act (RSBC 1979, c.272), the Forest Act (RSBC 1979, c.140) and the Range Act (RSBC 1979). The Ministry of Forests was formally established by the Ministry of Forests Act of 1978 which also sets an administrative structure and specifies the Ministry's major objectives and powers. The Forest Act sets out planning guidelines and policies.

The Ministry of Forests Act established the Ministry of Forests (MoF), directed by the Minister of Forests. Purposes of the MoF include encouraging the attainment of maximum productivity of a multiple use system for range and forest lands and a number of statutory functions. Basic purposes of the Ministry are established in Section 4 of the MoF Act:

> ..."to:
>
> (a) encourage maximum productivity of the forest and range resources in the Province;
>
> (b) manage, protect and conserve the forest and range resources of the Crown, having regard to the immediate and long term economic and social benefits they may confer on the province;
>
> (c) plan the use of the forest and range resources of the Crown, so that the production of timber and forage, the harvesting of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and cooperation with other ministries and agencies of the Crown and with the private sector;
>
> (d) encourage a vigorous, efficient and world competitive timber

processing industry in the Province; and

(e) assert the financial interest of the Crown in its forest and range resources in a systematic and equitable manner.

Section 4(c) provides the mandate for integrated resource planning and requires "consultation and cooperation ... with the private sector" where the "private sector" is interpreted by the MoF to include the public.

The MoF Act also requires the Minister to prepare a forest and range resource analysis every ten years containing an inventory of resources, a description of provincial forest and range management programs, and a summary of new developments in public policy that may affect forest and range resources. A five year forest and range resource program is required annually. Annual reports provide information on progress towards meeting objectives outlined in these documents.

The balance of the Ministry's mandate is contained in the Forest Act and the Range Act which, together, give the MoF the authority to manage all Crown forest and range resources in the province. In addition, these Acts define the overall framework within which the public and private resource interests in resource management will be accommodated.

The Forest Act establishes provincial forests and provides for their licensing, control and maintenance in all phases of utilization for the supply of timber (Vance 1990). Also recognised and provided for in this Act are recreational, wildlife, fisheries, watershed and other uses.

Under the Forest Act, the Chief Forester in the MoF may classify land as forest land

> "if the greatest contribution to the social and economic welfare of the province will be provided if land is predominantly maintained in successive crops of trees, forage or both, or maintained as wilderness" (Section 4).

Recommendations for forest land classification are forwarded from the districts level to the Chief Forester and further to Cabinet which has the authority to designate any forest land as provincial forest. Any Tree Farm Licence area is deemed a provincial forest (Ince and Pereboom 1984).

Within the Forest Act, the MoF is mandated to: classify and inventory forest land, determine the Allowable Annual Cut (AAC), and dispose of timber and manage harvests subject to integrated resource management considerations under a diverse set of tenures.

Under Sections 3 and 4 of the Forest Act, wilderness is confirmed as a legitimate use of provincial forests (BC MoF 1989). The Forest Act empowers Cabinet to give priority to wilderness resources by designating parts of the provincial forest as "wilderness areas". Lands under this designation must be managed to preserve wilderness values, or in a manner consistent with preserving its wilderness nature. Although mineral exploration and development is not specifically prohibited in wilderness areas, such activity must be approved by the Mine Development Review Process of the Ministry of Energy, Mines and Petroleum Resources.

The MoF's Public Involvement Program is governed by Ministry policy, but is not specifically mandated by legislation (other than the reference made above to Section 4(c) of the MoF Act). The overall goal of the program is "to improve forest management by including social aspects in forest management decisions" (BC MoF 1984b). The current public involvement policy was adopted in 1983 after a consultative process with interested publics from across the province. Recognizing the need for dynamic policies, this policy is intended to be responsive to changing public demands and resource management needs and is subject to periodic reviews (BC MoF 1984b)[2].

The Ministry of Forests also administers the Range Act. The Range Act is the vehicle by which private individuals may use Crown range. The Chief Forester and regional forest managers have duties under this Act. A range director assists in the administration of Crown range, specifying areas where licenses may be issued, recommending range management standards and objectives, and providing technical advice. A system of permits and licenses is established to regulate grazing and hay cutting on Crown range. Before licenses may be issued for an area, the regional forest manager must approve a "planned grazing system" for use of land for grazing and the dispersal of livestock over the land (Ince and Pereboom 1984).

[2] For a comprehensive account of the Ministry of Forests Public Involvement Process and its application to the MoF planning process, please refer to Vance (1990) and the background paper prepared for the Forest Resources Commission on this subject.

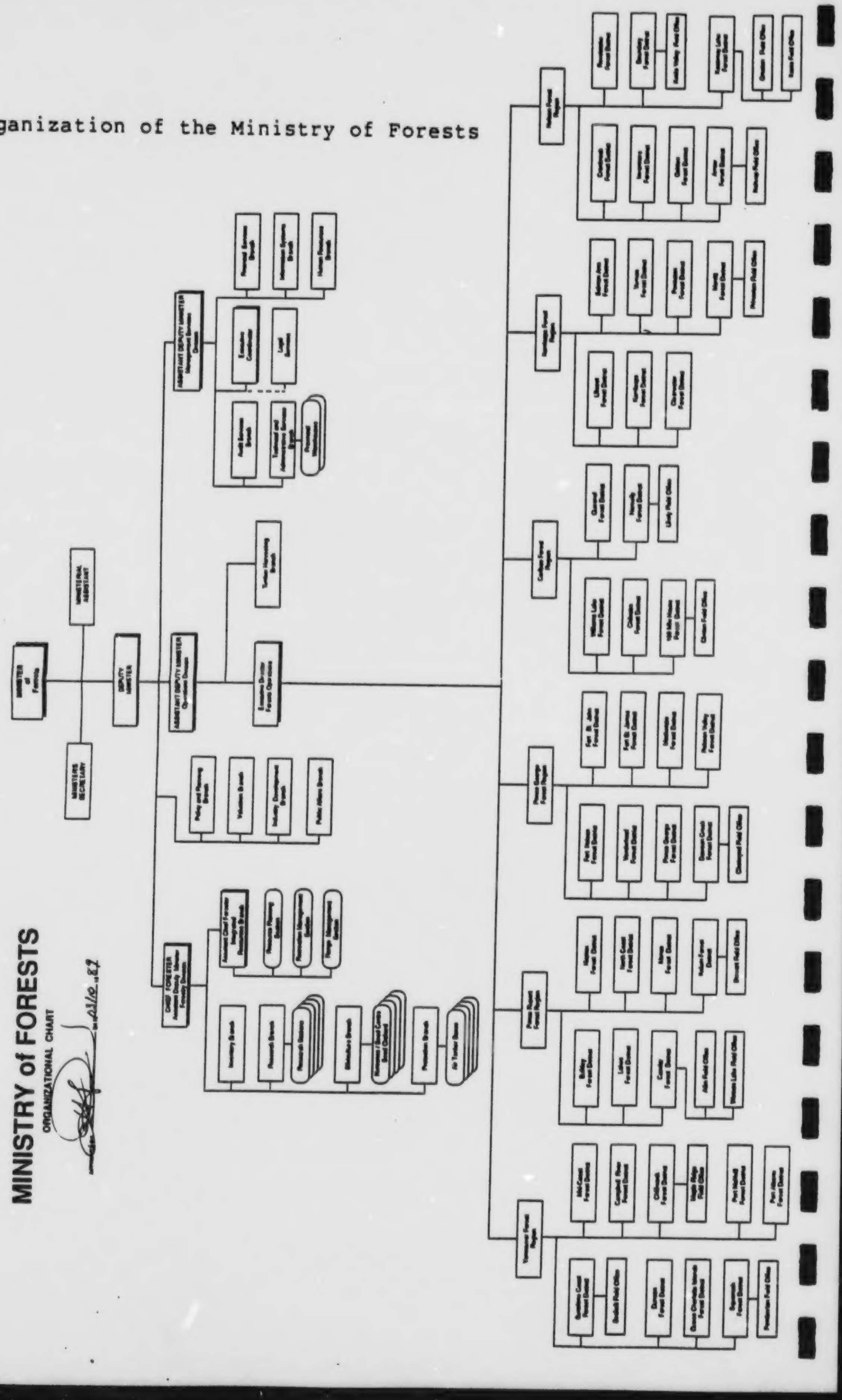
3.1.2 Organizational Structure

The Ministry of Forests is structured administratively into three levels: a headquarters in Victoria, six regions and forty three districts. Each level carries out administrative functions relating to the three program areas: timber, range and recreation. An organizational chart of the MoF is provided in Figure 4.

Government policy direction and program funding are established at headquarters level by the Ministry executive. Headquarters staff is responsible for developing planning policy and procedure, directing the Ministry's public involvement program, assisting the Chief Forester's determination of the annual allowable cut (AAC) for TSAs and TFLs, providing technical support for planning throughout the Ministry, and monitoring regional planning activities (BC MoF 1983).

Branches within headquarters develop policy and procedural guidelines to facilitate consistent implementation by districts. Administration and planning is carried out by the Resources Planning Section. Roles of this section include: assisting in the preparation of TSA Resources Management Plans and Local Resource Use Plans; reviewing TFL Management and Working Plans and supporting documents; carrying out timber supply analyses; coordinating interagency liaison; consulting the public; and

Figure 4. Organization of the Ministry of Forests


MINISTRY of FORESTS
ORGANIZATIONAL CHART
03/10 87

addressing environmental issues (Niezen 1990). The Provincial Public Involvement Coordinator is also included in headquarters staff.

Within the Resources Planning Section, the Forest Resource Analysis group plays an important role in conducting timber supply analyses of TSAs. The future supply of timber over the short term (twenty years) and long term (two hundred years) is projected using forest planning models which incorporate specific information and management assumptions.

Development of policies to ensure effective management of the Province's TFL system and other forms of tenure found within TSAs is the responsibility of Timber Harvesting Branch. Other responsibilities of this branch include reviewing TFL Management and Working Plans prepared by licensees and coordinating the government review of TFL applications. Inventory Branch maintains and coordinates an updated inventory program for the Province's forest land base.

Regional functions include the interpretation of provincial policies in a regional context, and the establishment of regional guidelines and priorities to meet program goals. A primary regional function is ensuring consistent and effective administration of policies and plans originating from headquarters. TSA Planning Coordinators and Planning Officers are responsible for coordinating and monitoring TSA planning functions, although this role is presently being decentralized to districts (Niezen 1989).

Districts are structured to implement programs and policies in accordance with regional guidelines and district procedures (BC MoF 1984a). District level staff are responsible for implementing TSA plans, adjudicating and monitoring resource development plans, and providing liaison with other ministries to ensure that natural resources are properly integrated into timber harvesting plans.

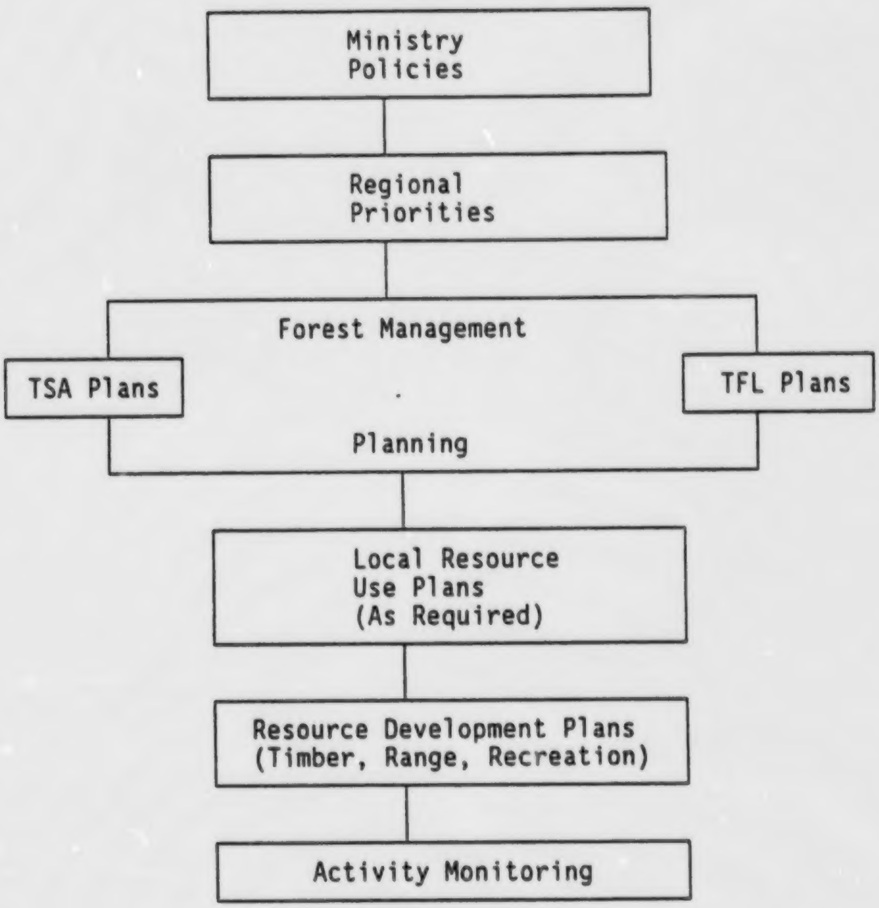
3.1.3 Planning Process

As discussed earlier, the Ministry of Forests Act, the Forest Act and the Range Act give the Ministry of Forests a broad mandate to carry out integrated resource planning on Crown land. Other ministries are consulted to determine their program objectives and how these interact with Ministry of Forests programs.

Today, forest planning is conducted through a hierarchical framework consisting of five planning levels: provincial policies, regional priorities, forest management planning, local resource use planning and resource development planning (see Figure 5). A summary of plans which result from these planning initiatives is provided in Figure 6.

Planning within the Ministry of Forests continues to evolve. Two policies for Integrated Resource Planning and Integrated Resource Management for Provincial forest lands were adopted in 1990. These policies provide a definition of integrated resource management and

Figure 5. Forest Planning Framework


Ministry of Forests

Forest Planning Framework

Ministry Policies
Regional Priorities
Forest Management Planning
TSA Plans
TFL Plans
Local Resource Use Plans (As Required)
Resource Development Plans (Timber, Range, Recreation)
Activity Monitoring

Figure 6. Summary of Ministry of Forests Plans

Summary of Ministry of Forests Plans

PLANS	planning level	planning responsibility	land unit	normal planning scale	normal planning horizon (years)		planning outputs
					detailed period	look-ahead period	
TSA plans TFL M&WPs	Forest Management Planning	Region	TSAs TFLs	1:100,000	20	200	- timber, range & recreation management strategies - AACs for timber
Local plans*	Local Resource Use Planning	District	watersheds, range units, etc.	1:20,000	5	20	- integrated resource management guidelines for designated development areas
timber Development plans range Development plans recreation Development plans	Resource Development Planning	District	five year development areas	1:5,000	5	5	- logistics for resource use development

* Local plans do not follow a standard naming convention. Examples of Local plans are the South Moresby Resource Plan or the Southgate Coordinated Resource Management Plan.

(Source: BC MoF 1983)

clarify principles for integrated resource planning. Integrated resource management is defined by the MoF as "a process which identifies and considers all resource values along with social, economic and environmental needs" and which "assigns resource use and management emphasis based on present uses, the mix of benefits produced, the continued capability of the land to produce benefits and social preferences." Integrated resource use planning is defined as

> a flexible and consultative decision-making process which examines the interaction of various resources, resource uses, developments and trends, and provides for interaction with stakeholders in the search for information, shared values, consensus and action that is both feasible and acceptable to the parties involved (BC MoF 1990).

The Resource Planning Manual is also undergoing revisions and a (draft) revised third chapter on Resource Management Planning reflects this focus on the implementation of integrated resource planning (BC MoF 1990). Recent changes to the planning process include the subdivision of TSAs into "Resource Emphasis Areas" (REA) through a type of zoning exercise, and the use of district planning committees to ensure that the interests of all affected agencies are considered[3]. The Ministry's planning process is designed to be flexible to account for regional differences and circumstances, and plans are intended to be flexible to account for changes in information, needs and values (Niezen 1990).

The following sub-sections discuss the purposes and products of the five planning levels in the hierarchical framework[4]. Tree Farm License planning is conducted by the licensee through the development of a Management and Working Plan using a three-tiered planning process. This process corresponds to the Forest Management Planning, Local Resource Use Planning and Resource Development Planning processes which follow.

---

[3] Other changes in the planning process include the utilization of geographically referenced data through the adoption of an Analytical Framework for Integrated Resources Management (AFIRM) (still in a developmental stage) (see Appendix 1).

3.1.3.1 Provincial Planning

Provincial planning is undertaken to establish broad provincial policies. These policies are developed within the context of government priorities and its view of society's priorities and goals, and correspond to the Forest Minister's own policies and goals. Examples of provincial policies include the Public Involvement Policy, the Integrated Resource Planning Policy and the new policy framework for managing wilderness in provincial forests. Ministry policy is approved by the Deputy Minister and documented in the Ministry's Policy Manual.

The Ministry of Forests Ten Year Forest and Range Resource Analysis and the Five Year Forest and Range Program are prepared through the provincial planning process. The Resource Analysis provides an account of provincial resources and consists of an inventory of the forest and range resources, a description of the extent of forestry activities, an analysis of trends and forecasts, and a description of the programs undertaken. The last Resource Analysis was prepared in 1984 and is to be prepared every ten years thereafter. The Five Year Forest and Range Program, required annually by statute, is intended to direct the integrated management program and sets broad priorities and targets based on the supply and demand evaluation of the Resource Analysis.

---

[4] Appendix 1 provides a discussion of the processes and analytical methods used in resource management planning and development planning to achieve these purposes and products.

At the provincial level, the Chief Forester sets the Allowable Annual Cut (AAC) for each TSA/TFL and aggregates these for the province. Headquarters staff provide policy direction and procedural guidance for regional staff, monitor regional planning activities, and provide technical support in the form of timber supply analyses.

Public participation is not officially required at the provincial level. When used, public participation at this level is characterized by briefs from organizations to ministers or Cabinet, royal commissions, formal conferences and political advisory groups (BC MoF 1981).

3.1.3.2 Regional Priorities

There are six forest regions in the province. Within the context of provincial policies and goals and under the Regional Managers's direction, regional staff are responsible for coordinating planning activities with industry and other ministries. Regional priorities are developed in the form of tentative timber, range and recreation production targets set for TSAs and TFLs in each region. To date, no regional plans have been completed or drafted; priorities and production targets have simply been established. This is accomplished through an informal process of consultation and discussion with the forest industry and the regional resource managers of other government agencies (Vance 1990).

Regional managers assess resource management priorities and allocate resources to District Managers for timber, range and recreation management programs within TSAs and TFLs. Regional coordination is provided for inter-ministry activities and for the preparation of TSA plans with appropriate public involvement procedures. Monitoring and evaluation of district performance is also provided at the regional level (BC MoF 1983).

3.1.3.3 Forest Management Planning

Forest management planning forms the strategic basis for developing and coordinating forestry programs carried out by the ministry and licensees. This constitutes the highest level at which comprehensive planning takes place for B.C.'s forest resources. Most of the planning effort is focussed here and this is the first level at which actual plans (resource management plans) are prepared; plans are developed for the lower three planning levels only.

The MoF planning framework also divides the planning process into seven steps which form a systematic approach to dealing with planning problems the resource planner may encounter. The planning steps are:

1. Preliminary organization
2. Information assembly

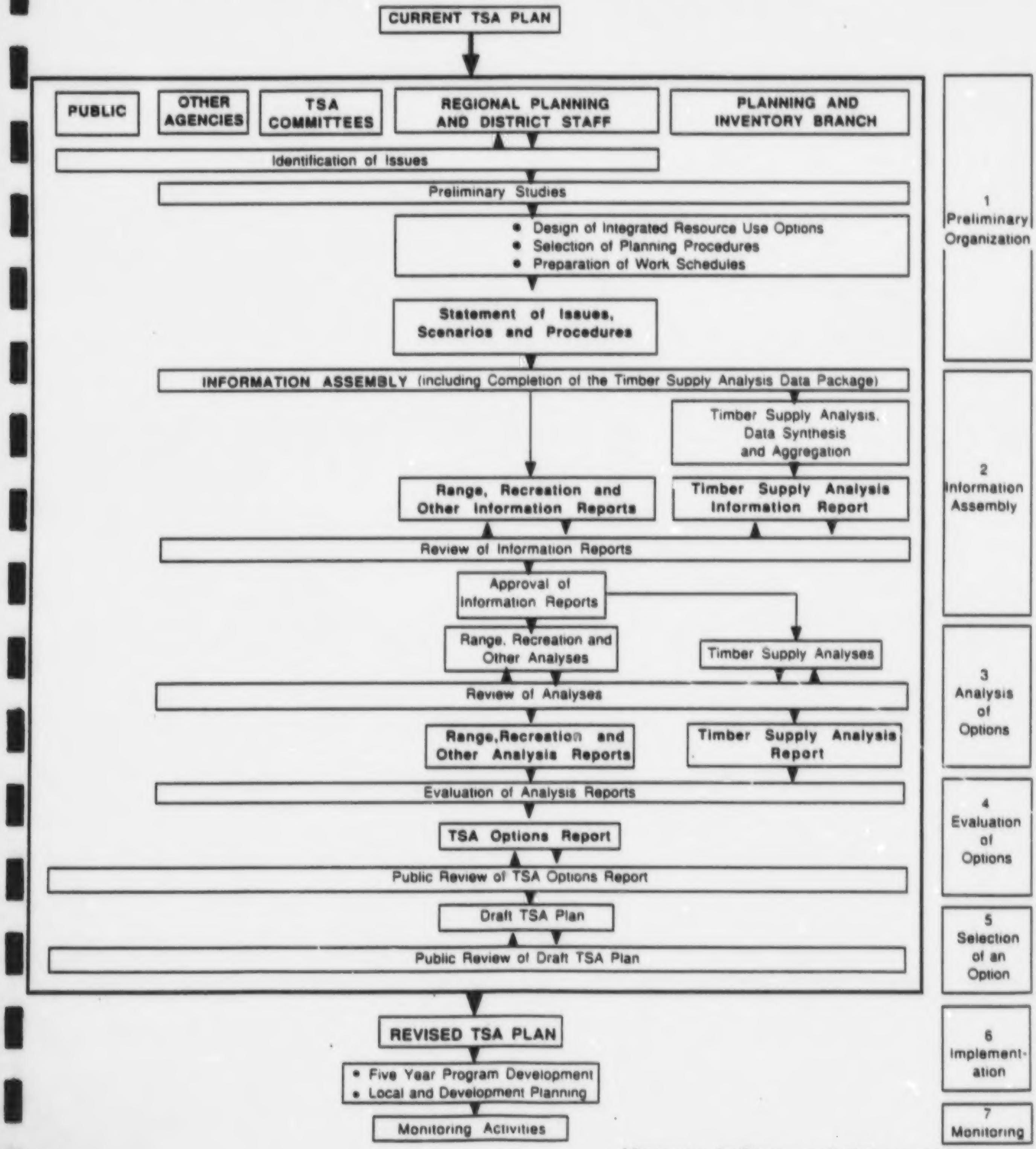
3. Analysis
4. Evaluation of options
5. Selection of an option
6. Implementation
7. Monitoring

The relationship of these steps to the TSA and TFL planning processes is illustrated in Figures 7 and 8, and outlined in greater detail in Appendix 1.

Forest management planning for individual TFLs and TSAs provides the link between broad, largely non-quantitative, provincial and regional level policies and priorities, and more detailed, area-specific resource use and resource development plans (BC MoF 1983).

Resource management plans are developed and maintained for each TSA and TFL (see Figures 7 and 8 for flowcharts of the TSA Resource Management Planning process and the TFL Management and Working Plan (TFL M&WP) planning process). The Forest Service develops and revises TSA Resource Management Plans on a regular basis for each TSA. Similarly, TFL holders (licensees) develop TFL Management and Working Plans (TFL M&WPs) for each TFL. Forest management planning determines the rate of harvest for timber and its subsequent apportionment, allocation among tenures and licenses, and the location of licensee's 20-year supplies of Crown timber (BC MoF 1985). The resulting TSA Resource Management Plans and TFL M&WPs constitute guidelines for resource management and set out strategic resource management goals and objectives for timber, range, recreation and other resources, resource use assumptions and

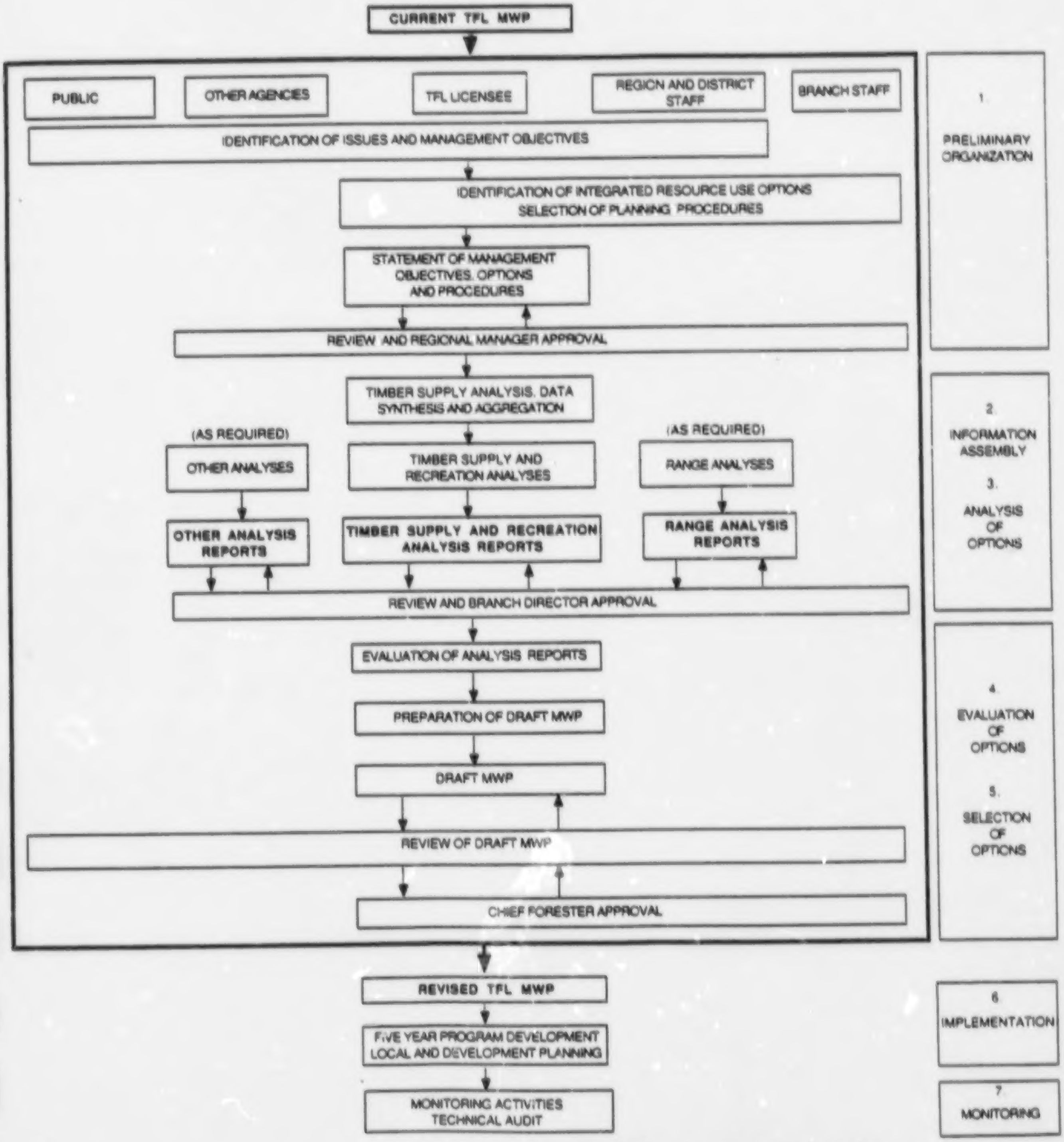
Figure 7. Timber Supply Area Planning Process


CURRENT TSA PLAN
PUBLIC
OTHER AGENCIES
TSA COMMITTEES
REGIONAL PLANNING AND DISTRICT STAFF
PLANNING AND INVENTORY BRANCH
Identification of Issues
Preliminary Studies
• Design of Integrated Resource Use Options
• Selection of Planning Procedures
• Preparation of Work Schedules
Statement of Issues, Scenarios and Procedures
INFORMATION ASSEMBLY (including Completion of the Timber Supply Analysis Data Package)
Timber Supply Analysis, Data Synthesis and Aggregation
Range, Recreation and Other Information Reports
Timber Supply Analysis Information Report
Review of Information Reports
Approval of Information Reports
Range, Recreation and Other Analyses
Timber Supply Analyses
Review of Analyses
Range, Recreation and Other Analysis Reports
Timber Supply Analysis Report
Evaluation of Analysis Reports
TSA Options Report
Public Review of TSA Options Report
Draft TSA Plan
Public Review of Draft TSA Plan
REVISED TSA PLAN
• Five Year Program Development
• Local and Development Planning
Monitoring Activities
1 Preliminary Organization
2 Information Assembly
3 Analysis of Options
4 Evaluation of Options
5 Selection of an Option
6 Implementation
7 Monitoring

(Source: Andrews and Higman 1986)

Figure 8. Tree Farm License Management and Working Plan Process

TREE FARM LICENCE MANAGEMENT AND WORKING PLAN PLANNING PROCESS.


CURRENT TFL MWP
PUBLIC
OTHER AGENCIES
TFL LICENSEE
REGION AND DISTRICT STAFF
BRANCH STAFF
IDENTIFICATION OF ISSUES AND MANAGEMENT OBJECTIVES
IDENTIFICATION OF INTEGRATED RESOURCE USE OPTIONS
SELECTION OF PLANNING PROCEDURES
STATEMENT OF MANAGEMENT OBJECTIVES, OPTIONS AND PROCEDURES
REVIEW AND REGIONAL MANAGER APPROVAL
TIMBER SUPPLY ANALYSIS, DATA SYNTHESIS AND AGGREGATION
(AS REQUIRED)
OTHER ANALYSES
TIMBER SUPPLY AND RECREATION ANALYSES
(AS REQUIRED)
RANGE ANALYSES
OTHER ANALYSIS REPORTS
TIMBER SUPPLY AND RECREATION ANALYSIS REPORTS
RANGE ANALYSIS REPORTS
REVIEW AND BRANCH DIRECTOR APPROVAL
EVALUATION OF ANALYSIS REPORTS
PREPARATION OF DRAFT MWP
DRAFT MWP
REVIEW OF DRAFT MWP
CHIEF FORESTER APPROVAL
REVISED TFL MWP
FIVE YEAR PROGRAM DEVELOPMENT
LOCAL AND DEVELOPMENT PLANNING
MONITORING ACTIVITIES
TECHNICAL AUDIT
1. PRELIMINARY ORGANIZATION
2. INFORMATION ASSEMBLY
3. ANALYSIS OF OPTIONS
4. EVALUATION OF OPTIONS
5. SELECTION OF OPTIONS
6. IMPLEMENTATION
7. MONITORING

(Source: Andrews and Higman 1986)

designated supply areas for the next 20 years (Vance 1990). Five year Management Working Plans for TFLs set the approved AAC for each license area and outline objectives for timber harvesting, forest protection and integrated resource management.

Yield analysis calculations are used in the determination of TSA/TFL Allowable Annual Cut levels. Resource management plans are prepared every five years, or sooner if required. Overall coordination for forest management planning is a regional responsibility.

Resource Management Plans for TSAs contain:

1) descriptions of resource management issues and objectives (including other agency objectives);

2) targets for timber, range and recreation (expressed as quantitative, short-term and long-range forecasts);

3) resource use assumptions underlying these production targets;

4) maps showing resource emphasis decisions;

5) management strategies for achieving the production targets for timber, range and recreation;

6) management direction including integrated resource use guidelines for preparing Local Resource Use and Resource Development Plans; and

7) license timber harvesting areas over the next 20 years (BC MoF 1990).

Detailed tactical integrated resource plans (Local Resource Use Plans and resource development plans) are linked to these broader strategic plans.

Public involvement in TSA planning is conducted in accordance with

Ministry public involvement policies and procedures. The Ministry is required to notify the public about opportunities for input. Public consultation is provided during the following stages: issue identification stage; review of draft terms of reference; review of the TSA Options Report; prior to the determination of an AAC; and through a public review of draft TSA plans before the approval of final, revised TSA plans.

TSA planning is managed by TSA committees with Ministry of Forests and licensee representation, and is conducted for a 20 year period with reviews required every 5 years. Recently, the MoF proposed the creation of district planning committees to prepare these plans. TSA planning will then be assisted by two types of committees: a district planning committee and a TSA Steering Committee (already existing). District planning committees are still at a developmental stage, but their role has been identified. Appointed by the District Manager, the district planning committee will be chaired by a Ministry of Forests planner and comprised of representatives from each of the resource agencies most directly affected. When formed, the district planning committee will include representatives from the TSA Steering Committee who will advise and provide information and assist planners on the timber resource analysis or other technical matters as required. Representatives from other agencies may also chair subcommittees dealing with specific issues, and these bodies will provide technical expertise to flesh out feasible options. Relevant licensed resource users may also be included on these subcommittees. The district planning committee will be the main committee involved in the preparation of Resource Management Plans. Public involvement will also be at the discretion of this committee.

TSA Steering Committees consist of representatives from the Ministry of Forests, resource agencies that promote other, non-timber forest and environmental resources like the Ministry of Environment and federal Fisheries, and forest industry representatives who advise on technical matters such as timber resource analysis (Vance 1990). This committee is convened on an "as needed" basis under the direction of the Regional or District Manager with representatives selected to reflect specific needs of the area. The Steering Committee focuses on timber issues and advises on the development of management options, conflict resolution between operators and other resource users, environmental, wildlife and fish habitat issues, recommendations for the resolution of various industry, environment and agency concerns, and specific management issues as they arise (Vance 1990). A permanent body, the Steering Committee functions during the forest management planning process in the development of terms of reference, review of analysis reports, and assisting in the development of Options Reports.

The planning process for TFL Management and Working Plans is summarised in Figure 8. TFL planning is similar to TSA planning except that planning is done by the licensee with Ministry consultation and technical review, and Chief Forester approval. Steering committees are not part of the planning structure on TFLs and opportunities for public participation are limited to two stages in the planning process: public submissions are solicited when planning for a Management and Working Plan is initiated, and the public is invited to review the contents of completed draft Management and Working Plans.

Under the supervision of an Operations Manager, the Planning Resource Officer and the Timber Resource Officer are responsible for planning TSAs as well as reviewing and giving direction to TFL Management and Working Plans (Niezen 1989). Ultimate approval of both of these plans is given by the Chief Forester of the Ministry of Forests. The Minister of Forests approves the apportionment plans for TSAs. Plan implementation is the responsibility of District staff who use these plans to establish forest management program proposals for the Ministry's Five Year Program. Monitoring involves all levels of staff.

A recent addition to the resource management planning process is the sub-division of TSA units into "Resource Emphasis Areas" (REAs) to assist in identifying resource use issues more clearly. By subdividing TSAs into homogeneous planning units defined on the basis of similar features, resource potentials, management requirements and operational constraints or combinations of these (BC MoF 1990), REAs may then be placed into general use and management categories and assigned site-specific prescriptions. Categorization of REAs also helps in the definition of analytical needs and identification of resource use conflicts.

Once plotted on TSA maps, the Resource Emphasis Area designations will be discussed with the district planning committee, the TSA Committee and the public. Map labels are used to indicate resource use preferences and constraints to other resource users (BC MoF 1990). Through this form of zoning exercise, issues and needs may be identified for a particular area for all stakeholders. Objectives articulated for all resources may then be used in a process of negotiation to achieve consensus amongst resource managers in the allocation of forest lands. Each issue or concern is incorporated into the development of options for consideration in the planning process[5].

3.1.3.4 Local Resource Use Planning

Local Resource Use Planning is used to resolve multiple resource use conflicts for areas within TSAs and TFLs designated for development. Local Resource Use Plans (LRUPs) set out area-specific integrated resource management objectives and prescriptions and are prepared for smaller geographic areas within the TSAs and TFLs. These plans are used to establish a compatible set of resource guidelines and objectives that enable resource development planning to proceed, particularly in response to perceived resource use conflicts. Planning at this level is conducted on an "as-needed" basis. Local resource use planning is initiated to resolve multiple resource use conflicts or when more intensive analysis and planning is required within Timber Supply Areas and Tree Farm Licenses. The use of this level of planning and the form it takes corresponds directly to the potential for conflict.

---

[5] This process assists in defining analytical needs and in identifying resource use conflicts and is discussed in greater detail in Appendix 1.

The goal of Local Resource Use Planning is to fully account for non-timber values, and to minimize the environmental impact of logging (BC MoF 1985). Planning is generally conducted on a watershed level and the type of action is dependent on the questions being dealt with. Currently, there are approximately 400 LRUPs in the province (Vance 1990), including those prepared for areas such as South Moresby, the Lower Stikine, and Meares Island.

Local Resource Use Plans specify how timber harvesting (or range and recreational development) should take place. Specific objectives and constraints for integrated resource use are specified and the onus is placed on the licensee to prepare and submit to the Forest Service a Development Plan which complies with the Local Resource Use Plan requirements (BC MoF 1985).

Local resource use planning may range from consultation between government agencies, to task forces and joint planning teams; the choice will reflect the local situation. Again, the complexity of this process and the extent of public involvement will depend upon the potential for resource use impacts and conflicts. Community watershed plans, coordinated resource management plans and resource folio plans may be used to resolve resource use conflicts and establish integrated resource use management guidelines for local areas within TSAs and

TFLs. This process usually provides a five- to ten-year development perspective. District staff are responsible for Local Area Resource Planning. The responsibility for resource use decisions is also dependent upon the potential for resource use impacts and conflicts, and ranges from the District Manager to MoF headquarters.

3.1.3.5 Resource Development Planning

Resource development planning addresses specific parts of TSAs or TFLs and outlines the details of how resource development will actually take place on those areas. Methods, schedules and responsibilities for accessing, harvesting, renewing and protecting the resource are specified to enable site-specific operations to proceed. The resource management plan strategies and integrated resource management objectives identified through local resource use planning are used. Resource development planning occurs at two levels: five year Resource Development Plans broadly outline proposed cut-blocks and preharvest silviculture prescriptions, and annual operational plans detail the logistics for resource use development.

Five year Resource Development plans provide more specific planning and a rational framework for the entire planning unit in which operational planning can be conducted. Cutting permits which outline specific cut-block boundaries and list conditions or harvest restrictions to protect non-timber resources are included in the operating plans.

Examples of resource development plans include: those required for the implementation of a TFL Management and Working Plan (TFL M&WP); resource development plans required of Forest License and Timber Sale License timber tenures within TSAs; Range Unit Plans; and others such as recreational site development plans, silviculture development plans and major road development plans (BC MoF 1983).

Resource assessments are conducted to provide a perspective of all resources in the planning unit, to provide information and prescriptions for non-timber resources, and an outline of the total, harvestable timber producing area.

In the case of TFLs, licensees draft resource development plans for approval by the District Manager. These plans provide specific information regarding harvesting and forestry projects in the license areas and are supplemented by annual updates. Comments obtained through consultation with other government agencies and from public reviews must be incorporated by the licensee. Preharvest silvicultural prescriptions prepared by the licensee must be approved by the MoF. These documents provide specific timber and topographic information from proposed harvesting areas and provide licensees with the authority to harvest timber in designated areas according to specific requirements (Niezen 1989).

3.2 MINISTRY OF CROWN LANDS

3.2.1 Legislative Mandate

The Land Act (RSBC 1979, c.214) provides the Ministry of Crown Lands with the authority to administer those Crown lands not specifically designated to the control of any other Ministry, branch or agency of the Provincial government. This area comprises 379,606 hectares or 0.4% of the provincial land base (BC MoCL 1989a).

The main purpose of the Land Act is to regulate the disposition of Crown land in B.C. A number of other provincial ministries have power to use Crown lands for special purposes. For example, the Minister of Transportation and Highways may designate Crown land as a highway under the Highway Act (Ince and Pereboom 1984).

3.2.2 Organizational Structure

The Ministry of Crown Lands has eight regional offices throughout the province. Below the Ministerial level of decision making, authority is designated to a Land Commissioner and then to Regional Directors. Much of the administrative work is delegated to a Senior Lands Officer.

3.2.3 Planning Process

The Land Disposition Referral Procedure is the main Crown land review process and applies to applications for new and replacement land tenures as well as to proposals for reserves, designations and notations under the Land Act (Andrews and Higman 1986). The purpose of this procedure is to obtain the highest and best use of Crown land, to achieve interagency cooperation and to minimize conflicts between resource development and environmental protection.

Allocation of Crown land follows a set of principles including: maintaining a quality environment, minimizing conflicts among potential users, making allowance for present users, retaining opportunities for growth and change, type and interest of the tenure, boundaries of the tenure, and any special conditions (BC MoCL 1988). Crown land rights take the form of fee-simple, lease, right-of way, license, and permit holdings.

Requests for the purchase or use of undeveloped Crown land are referred to the Land Commissioner and then forwarded to interested agencies. Upon receiving referral responses, the Commissioner provides recommendations to the Regional Director of the Ministry of Crown Lands. If determined to be non-controversial, the proposal is then referred to the Deputy Ministers for approval. Public response is solicited through publication in the B.C. Gazette, local papers, and often through the posting of notices on site. Incorporation of input into the decision-making process is at the discretion of the Commissioner.

3.3 MINISTRY OF PARKS

The Ministry of Parks is responsible for administering any protected lands designated by Cabinet such as Provincial Parks and Ecological Reserves. Provincial parks encompass 5,364,501 hectares and designated Ecological Reserves account for an additional 107,321 hectares. In total, the Ministry of Parks administers 5.7% of the provincial land base (BC MoCL 1989a).

3.3.1 Legislative Mandate

The Ministry of Parks administers the Park Act (RSBC 1979, c.309) and the Ecological Reserves Act (RSBC 1979, c.101). The Park Act designates the Minister of Parks to be responsible for all resources within park boundaries. BC Parks' is mandated to administer the conditions of the Act. This Ministry's mandate is to maintain a park system "that will both protect the natural environment and provide recreational opportunities" (BC MoP 1990a).

The Park Act is the primary statute controlling parks in the province. It defines a "park" as any Crown land established as such under the Act. The legal position of a park depends upon its designation by Cabinet as Class A, C, or Recreation Area:

1. Class A:

Most parks in B.C. are Class A Parks (provincial parks), occupying 73% of Provincial park lands (BC MoCL 1989a). These are dedicated to the preservation of their natural environments for the inspiration, use and enjoyment of the public (BC MoP 1990a) and are the most highly protected. Land use is severely restricted in provincial parks and no commercial resource harvesting is permitted. Permits are only issued for activities deemed necessary for the maintenance of recreational values of the park.

2. Recreation Areas:

Park reserves may be temporarily classified as Recreation Areas if they are having mineral resource evaluations done under a time-limited tenure. No commercial logging is permitted on these lands and they may become Class A parks upon completion of the evaluation. Currently, 16.7% of B.C.'s park lands are designated as Recreation Areas (BC MoCL 1989a).

Lands can be added to the park system before the extent and value of their sub-surface resources are known, although time-limited mineral claims may be staked for resource evaluation in newly established recreation areas (BC MoP 1990a). These claims are managed by the Parks Branch to ensure minimum disturbance of habitat over a minimum ten year period. During this time, or after the time-limited tenure expires, the Parks Branch may seek reclassification of the land as Class A park land (BC MoP 1990a).

3. Class C:

Class "C" or community parks represent a small proportion of the system and are being turned over to regional and municipal governments for administration (BC MoP 1990a). In the meantime, these are each administered by a separate board appointed by the Minister.

Under the Park Act, in addition to designating the class of park, the Minister must categorize parks according to their purpose (e.g. to preserve the environment or ecology). Park development must then be consistent with the categorization, and permits and leases must be given in accordance with these purposes (Ince and Pereboom 1984).

Changes in park boundaries and designations are made by Order-in-Council or by passing an amendment to the Park Act (Ince and Pereboom 1984). Ad-hoc referrals remain the main method of incorporating land into the park network, although BC Parks is presently undergoing a public process for planning future additions to the provincial parks system (see Section 3.3.3).

The Park Act is subject to the Environment and Land Use Act and the Waste Management Act, but no others (Ince and Pereboom 1984). Municipal by-laws that are inconsistent with the Act may be suspended. Cabinet is given wide powers to make park regulations that are not inconsistent with the Act.

The Park Act also authorizes the establishment of nature conservancy reserves. These areas receive the highest protection and are usually established within provincial parks. No natural resource extraction permits may be issued for a nature conservancy. In addition, these areas may be declared ecological reserves under the Ecological Reserves Act which empowers Cabinet to reserve provincial public lands for ecological purposes. Lands under such a designation are reserved specifically to protect the unique natural environment of the area. Cabinet has the power to add, delete or cancel ecological reserves entirely. However, no lands in an ecological reserve can be disposed of in any way (Ince and Pereboom 1984). To date, 0.1% of B.C.'s Crown lands have been designated as Ecological Reserves (BC MoCL 1989a).

3.3.2 Organizational Structure

The Ministry of Parks is managed out of a headquarters in Victoria with three regional offices, thirteen zones and twenty nine districts. Proposals for new parks are reviewed by headquarters and by the Regional Director in each regional office. Upper level decisions on activities within parks and Recreation Areas are made by the Assistant Deputy Minister, Deputy Minster or Minister. Upper level decisions on new park proposals are made by the Minister and Cabinet (Andrews and Higman 1986).

Provincial Cabinet has the authority to establish parks and Recreation Areas, and approves park plans addressing park uses and park boundaries. Contentious issues are referred to the Cabinet Committee on Sustainable Development for attention prior to Cabinet approval. The Minister of Parks is responsible for approving the Ministry's System Plan and master plans for existing parks. Completion of master plans for each park is the responsibility of Park Managers and District Managers.

3.3.3 Planning Processes

The Ministry of Parks policies, goals and management principles are outlined in the policy statement "Striking the Balance" (BC MoP 1990a). This Ministry has separate planning processes for the allocation of new parks and for the preparation of plans outlining activities within parks.

3.3.3.1 The Allocation Planning Process

The overall goal of the Parks system is to achieve representation of the diversity of natural environments found across the province and to conserve these in an ecologically sustainable framework. At the same time, this Ministry must provide opportunities for nature appreciation, outdoor recreation and environmental education of the general public (BC MoP 1990a). BC Parks is currently undergoing a public process for planning future additions to the provincial park system. This initiative is intended to assist BC Parks in developing an overall plan to guide the future of the Parks System. The public, industry and other government agencies are being encouraged to actively participate in this process.

Prior to the current "Parks Plan '90" initiative, BC Parks has used the following general process to identify new park lands. The Ministry has put an overall systems plan in place outlining criteria for identifying lands appropriate for incorporation into the park network. In this systems plan, potential park lands are identified and priorized on the basis of their: relative abundance in the province; relative importance as recreational, educational or visual resources; and significance for conservation of natural features (BC MoP 1990b).

Areas identified by the parks system plan as having a high priority, and/or areas that have been brought forward by public interest are reviewed on an ad-hoc basis by the Ministry. Generally, lands identified as having parks potential are designated as Recreation Areas first. These lands are then evaluated for other resource values which may include mineral exploration. At the same time, the Ministry undertakes discussions with other ministries to attain agreement on the ultimate designation of potential parks. Currently the Parks Branch is working on a referral process through which responses of all agencies can be coordinated and evaluated. Once the evaluation is complete, proposals for new parks will then be routed from Parks headquarters to the Deputy Ministers Committee on Sustainable Development and Environment and Land Use, to the Cabinet Committee on Sustainable Development, and then to Cabinet (Munn 1990).

3.3.3.2 Park Management Plans

Park management plans or "master plans" complement the systems plan and outline land use planning within parks and recreation areas. A comprehensive document, park master plans establish the objectives, policies and strategies intended to guide management and development of particular parks or related boundaries, acquisition, developments, resource management and visitor services. Master plans are developed for large (over 5,000 hectares) parks subject to major resource or user group conflicts, high public interest or substantial capital development (Andrews and Higman 1986).

A sub-regional system planning process identifies the general conservation and recreation role of each park and recreation area. Following resource inventory and resource assessment, a role statement is developed for each park. The master plan then defines more specific objectives for: a) resource conservation and management; b) the types and levels of outdoor recreation opportunities to be provided; and c) the quantity and quality of facility development necessary. It also sets general guidelines, as appropriate to direct further actions to achieve these objectives.

Within each park management plan, a park is also divided into zones. Zoning within parks assigns specific management objectives, and a list of activities and facilities deemed compatible with the natural resources for each area. Five zones have been identified, including intensive recreation, natural environment, special feature, wilderness recreation, and wilderness conservation (BC MoP 1990a). Changes to park or recreation area zoning constitutes an amendment to the master plan and therefore requires approval of the Assistant Deputy Minister.

The Regional Director develops Master plans through discussions with relevant agencies and contact with interested residents and organizations. Inter-ministry referral processes such as protocol agreements with the Ministry of Forests are used in the development of park management plans.

3.4 MINISTRY OF ENVIRONMENT

3.4.1 Legislative Mandate

The Ministry of Environment plays a small role in the planning and allocation of provincial Crown lands. The Ministry of Environment Act of 1978 forms the Ministry of Environment (MoE) which is responsible for the maintenance of a quality environment for all living resources, including people. The primary mission of the MoE is "to protect, restore and enhance the integrity, diversity and quality of natural ecosystems and human environments." A secondary objective is "to provide the best possible array of social and economic benefits from the province's environmental resources" (BC MoE 1990).

The Environment Management Act (S.B.C. 1981 c.14) authorizes the Minister of Environment to manage, protect and enhance the environment through planning and policy development, and to develop management plans that both provide a framework for environmental decisions and match environmental priorities with the concerns of other interests. Enabling provisions of this Act direct this ministry's planning program toward the development of sound resource management standards for provincial water resources, fish and aquatic life, wildlife resources, waste and air (Ince and Edwards 1984).

Specifically, the Environment Management Act empowers the Minister:

1. to develop environmental management plans for provincial areas, such as the Cowichan Estuary;
2. to require that proponents produce and submit an environmental

assessment when a proponent's proposal is deemed by the Minister to have an adverse environmental impact and its impact cannot be determined on the basis of available information;

3. to issue an order to delay or stop activities that could have serious or irreversible effects on the environment;
4. to declare environmental emergencies and to make emergency protection orders; and
5. to appoint a person or committee to conduct an inquiry into environmental issues (CCREM 1989).

The Environment Management Act also established the Environment Appeal Board to hear appeals on provincial environmental decisions.

The Wildlife Act (S.B.C. 1982. c.57) gives the Ministry of Environment the mandate to protect and conserve wildlife species and to regulate the consumptive recreational use of wildlife resources in the province. The habitat base on which the resource depends is often under the control of other government ministries. However, with Cabinet approval, the Minister of Environment may designate Crown land as a Wildlife Management Area. These areas include Management Sanctuaries for the protection of wildlife, and Critical Habitat Areas to protect feeding and breeding grounds. Wildlife Management Areas are acquired by purchase or gift.

The Ministry also administers its mandate under a number of other Provincial and Federal acts, including the: Water Act, Water Utility Act, Fisheries Act (Canada), Waste Management Act, Pesticide Control Act, and Environment and Land Use Act.

3.4.2 Organizational Structure

The Ministry of Environment's administrative structure is comprised of a headquarters in Victoria and six regional offices throughout the province. This Ministry has recently undergone re-organization. Headquarters retains the responsibility for program direction and policy making while regions maintain responsibility for their implementation. Individual branches within headquarters including the Wildlife Branch, Fisheries Branch, and Integrated Management Branch are responsible for resource planning for their respective resource areas. Operational plans are prepared at the regional level.

3.4.3 Planning Process

This Ministry's mandate for administering provisions of the Wildlife Act requires that it manage and protect wildlife populations and their habitat. Under this Act the Ministry develops integrated resource use plans involving wildlife. A number of planning processes are used in the management of air, water, wildlife and fisheries resources, including strategic plans to integrate various environmental management programs. Resource management plans and agreements by affected resource agencies are necessary in the designation of Wildlife Management Areas as they may be situated in provincial forests (Niezen 1989).

Under the Environment Management Act, the Ministry of Environment is responsible for developing policies for the management, protection and use of the environment; developing environmental management plans;

preparing integrated assessment of major project development proposals; managing major, unexpected environmental emergencies or hazards; and enforcing environmental protection regulations (MoE 1990).

A Recreation Corridor Policy outlines a planning process to achieve integrated planning for specific recreation corridors. This policy does not require reallocation of land. Instead, the land is cooperatively managed by the existing agencies and new uses of land within the corridor are regulated according to the guidelines of the policy.

As the MoE has responsibility for the management of water, fish and wildlife resources in the province, they are also involved in integrated resource planning of forest lands through a hierarchy of corporate agreements with the Ministry of Forests. These include legislation, working plans on Tree Farm Licenses and strategic plans on Timber Supply Areas, Five Year Resource Development Plans and cutting permits.

3.5 MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

The Ministry of Energy, Mines and Petroleum Resources responds to development proposals from industrial sectors. It administers Guidelines for Mineral Exploration and the Mine Development Review Process--two of the review processes used to assess mineral development on Crown lands.

3.5.1 Organizational Structure

While this Ministry does not have direct jurisdictional authority over Crown land allocation, legislated rights exist under the Mineral Tenure Act (S.B.C. 1988 c.5) for individuals or companies to undertake mineral resource exploration over the majority of B.C.'s Crown lands. Under the Mineral Tenure Act, a mineral claims process is used to secure legal rights to mineral resources. Access to a claim must be approved by the Ministry of Crown Lands. Below Cabinet level, proposals go through the Regional Inspector, the Chief Inspector, and finally the Minister of MEMPR who provides approval for all mine developments subject to conditions identified in an inter-ministry review. During the planning process, the mine proposal must be approved by other Ministries through the referral process of the Mine Development and Review Process.

A recent development in the administration of MEMPR's mandate has been the introduction of Bill 59, the Mine Development Assessment Act, which will formalize the Mine Development Review Process (Ringstad 1990). To date, this Bill has heard third reading in the provincial legislature and will become legislation once regulations are prepared. An additional change to the adminstration of this process has been the replacement of ELUC with the Cabinet Committee on Sustainable Development as the sponsor of the process.

3.5.2 Planning Process

Overlying the regular planning and allocation mechanisms provided by the Ministries of Forests, Crown Lands, and Parks, additional processes have been developed for project-specific designations. MEMPR administers the "Guidelines for Mineral Exploration" and the Mine Development Review Process; two mechanisms used in provincial land-use delineation.

3.5.2.1 Guidelines for Mineral Exploration

Mineral tenures give rights to mineral resources on property staked by a person making a claim. Once a mineral claim is made and approved by the Regional Inspector, the claimant has the legal right to those resources. In order to retain a claim, the claimant must pay an annual fee and submit proof of activity related to development of further exploration of that claim (BC MEMPR 1989a). The mineral tenure overrides other claims to the land although it does not give the mineral tenure holder any rights over other resources on the land.

Restrictions and conditions for mineral exploration are included in section 9 of the Mineral Tenure Act. Essentially, exploration can occur on all lands except provincial parks, or where restricted by conditions of the above Act (e.g. in orchards or on cultivated lands, where buildings are sited, etc.). Other ministries are limited in their power to restrict exploration on lands within their jurisdiction (Crook 1990).

Under the Land Act, the Ministry of Crown Lands must grant permission to acquire right-of-way for access to a mineral exploration. Notice must be given to land owners prior to disturbance of the surface, and persons engaged in exploration are liable to compensate the owner for loss or damage caused by their entry, occupation or use of the surface right-of-way (BC MEMPR 1989a).

A variety of permits and/or licenses may be required prior to any exploration activity in provincial forests. These include: a special use permit to occupy Crown land outside of the mineral tenure for access roads and campsites; a road permit; a free use permit to cut timber used directly in exploration activities; a license to cut timber from areas to be used in the exploration program; a timber sale license; and a burning permit (BC MEMPR 1989a). Any activities on provincial forest lands are under the direction and planning process of the Ministry of Forests, and subject to the Forest Act. Exploration activities in Recreation Areas are administered by the Ministry of Parks and MEMPR jointly. Approval of the reclamation plan is provided by both the Chief Inspector of Mines and the Regional Director of Parks (BC MEMPR 1989a).

3.5.2.2 Mine Development Review Process (MDRP)

Depending on the jurisdiction of lands in question, mine sites must be approved by the Ministry of Crown Lands, Ministry of Forests, MEMPR and the Ministry of Parks. The Chief Inspector of Mines is responsible for approving all Mine Plans and Reclamation Plans. Under the Mines Act, plans put forth by mining companies for new mines and major expansion of existing mines are subject to approval through the Mine Development Review Process (MDRP). As mentioned above, MDRP will be formally legislated upon passage of Bill 59, the Mine Development Assessment Act. The goal of this process continues to be "to integrate environment and economy by facilitating and expediting sound, publicly acceptable mining ventures in B.C." (BC MEMPR 1990b). This section outlines the nature of the non-statutory Mine Development Review Process and presents changes in the process which will accompany its legislation.

The Mine Development Review Process has applied to coal and hard-rock metal mines, but generally not to placer or quarry operations. Application of the process has been restricted to development and construction phases, and dedicated off-site infrastructure; it excludes exploration activities.

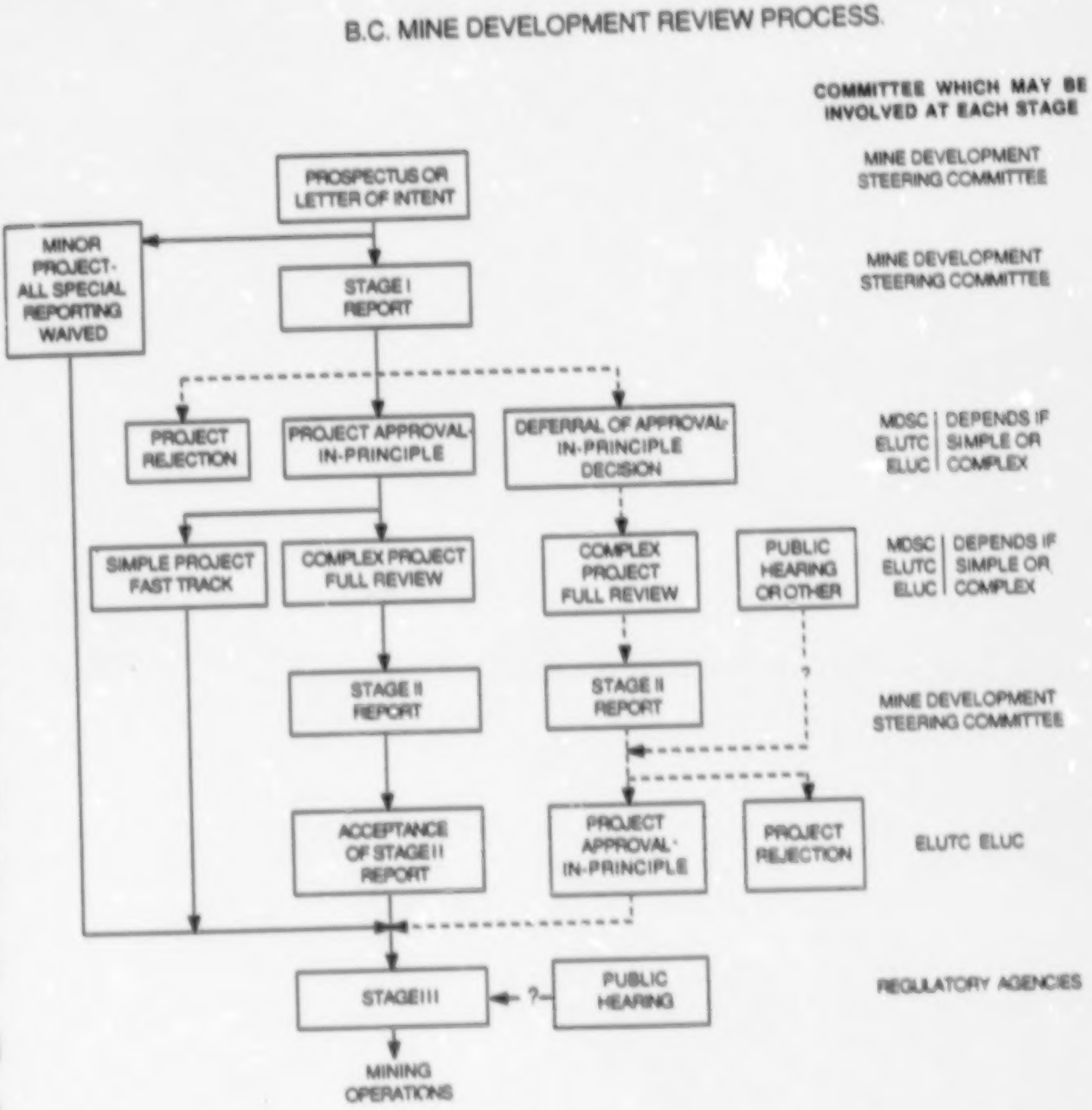
The Cabinet Committee on Sustainable Development (CCSD) sponsors the review process and has ultimate decision making authority. Any items which are referred to CCSD are first discussed with and reviewed by the

Deputy Ministers' Committee on Sustainable Development and Environment and Land Use (DMCSD/ELU). At the working level, the Mine Development Steering Committee (MDSC) administers the reviews. This committee consists of senior government representatives from six ministries including: MEMPR (Chairman); Environment; Municipal Affairs, Recreation and Culture; Transportation and Highways; Regional and Economic Development; and Native Affairs (BC MEMPR 1990b).

Recently, the MDSC has begun to delegate reviews of small or simple projects to a new system of six multi-agency regional committees (the Regional Mine Development Review Committees) for local handling by regional permitting staff. MEMPR acts as the lead agency for MDRP, chairs the Steering Committee and regional committees and provides technical and administrative support to these committees.

Under the Mine Development Review Process, project reviews function through a three-stage process (see Figure 9): (prospectus), Stages 1, 2, and 3. An introductory prospectus outlines reserves, exploration, mine site and off-site development proposals and projected production and manpower needs (BC ELUC 1975 in Day 1987). On the basis of the prospectus, the Mine Development Steering Committee makes a decision on whether MDRP should be applied. If it is determined that the project should undergo review, a Stage I study terms of reference is prepared by the MDSC.

Figure 9. Mine Development Review Process (MDRP)


B.C. MINE DEVELOPMENT REVIEW PROCESS.
COMMITTEE WHICH MAY BE INVOLVED AT EACH STAGE
PROSPECTUS OR LETTER OF INTENT
MINE DEVELOPMENT STEERING COMMITTEE
MINOR PROJECT- ALL SPECIAL REPORTING WAIVED
STAGE I REPORT
MINE DEVELOPMENT STEERING COMMITTEE
PROJECT REJECTION
PROJECT APPROVAL-IN-PRINCIPLE
DEFERRAL OF APPROVAL-IN-PRINCIPLE DECISION
MDSC ELUTC ELUC
DEPENDS IF SIMPLE OR COMPLEX
SIMPLE PROJECT FAST TRACK
COMPLEX PROJECT FULL REVIEW
COMPLEX PROJECT FULL REVIEW
PUBLIC HEARING OR OTHER
MDSC ELUTC ELUC
DEPENDS IF SIMPLE OR COMPLEX
?
STAGE II REPORT
STAGE II REPORT
MINE DEVELOPMENT STEERING COMMITTEE
ACCEPTANCE OF STAGE II REPORT
PROJECT APPROVAL-IN-PRINCIPLE
PROJECT REJECTION
ELUTC ELUC
STAGE III
?
PUBLIC HEARING
REGULATORY AGENCIES
MINING OPERATIONS

(Source: BC MEMPR 1989b)

At Stage I, the proponent must file a report which describes the project in detail, presents a detailed impact assessment, proposes adequate impact management strategies, and sets the stage for an approval-in-principle decision at the end of Stage I. When considered necessary, a Stage II report focusses on any identified deficiencies, completes outstanding impact assessment requirements, upgrades or finalizes proposed impact management strategies, and sets the stage for an approval-in-principle decision at the end of Stage II (that decision having been deferred from the end of Stage I) (BC MEMPR 1990a).

All projects, including those waived Stages I and/or II have been required to pass through Stage III (the licensing stage) at which stage project designs are finalized, and detailed permit application are filed by the proponent, and processed by regulatory agencies.

Approval-in-principle (AIP) has been granted following the filing of a prospectus (for projects which raised only minor or routine impact issues), or at the end of either Stage I or Stage II, depending on the degree of complexity of the impact issues raised during project reviews. The approval-in-principle decision has normally been made by the CCSD (or formerly, ELUC) for complex projects, and by the working level committees for straightforward projects (BC MEMPR 1990a).

By provincial policy, project proponents have been primarily responsible for public consultation. Official submissions by the proponent are considered public documents and reasonable public access to these documents must be provided. In addition, government review comments on a particular submission have also been available on request from the MDSC. Mine and reclamation plans have been published in the B.C Gazette, and intentions stated in local newspapers. Public hearings have been required at the discretion of the Chief Inspector of mines. Occasionally, hearings have been undertaken to solicit public concerns for integration into the process, but this has also been conducted at the discretion of the Minister or Chief Inspector.

Upon passage of Bill 59, the scope of the process will be broadened by making it applicable on a discretionary basis to other classes of mines besides coal and hardrock mineral mines. In addition, a mine development certificate will replace the approval-in-principle as the main form of approval issued under the MDRP. Disposition of applications for mine development certificates will follow one of four routes: referral of the application to an independent assessment panel for inquiry; acceptance of the application with whatever conditions are deemed necessary; returning the application to the proponent for upgrading; or rejection of the application (BC MEMPR 1990b).

If an application is referred to an independent assessment panel, the Ministers of Environment and MEMPR will jointly appoint the panel and provide the (public) terms of reference for its inquiry. Under the Act, public consultation will be required before an application is accepted for disposition, during the review and disposition of an application, and during an inquiry by an assessment panel (BC MEMPR 1990b).

3.6 OTHER BODIES

3.6.1 Environment and Land Use Committee

The Cabinet Committee on Environment and Land Use (ELUC), under the Environmental Land Use Act (RSBC 1979, c.110) has been responsible for integrating land and resource use policy and resolving land use conflicts elevated to the Cabinet level. ELUC also reviews the impact of major development project proposals. This key statute provides the government with sweeping powers to deal with land use problems. The Act established the Environment and Land Use Committee with the mandate "to ensure that all the aspects of preservation and maintenance of the natural environment are fully considered in the administration of land use ..." (s.3) (Ince and Pereboom 1984). Cabinet is thus given "literally unlimited powers in making orders and regulations to deal with any matter involving the environment or land use, as long as its actions are within the consitutional jurisdiction of the province" (Ince and Edwards 1984).

During the 1970s ELUC was also a vehicle for ensuring the coordination of decision-making in policies and issues of environmental matters which surpassed the interests of a single department. In early 1990 however, the Cabinet Committee on Sustainable Development was formed and has taken on the majority of ELUC's former responsibilities. ELUC remains as a statutory committee to fulfill roles such as acting as an appeal body under the Agricultural Land Commission Act (O'Gorman 1990) and to enact provisions of the ELUC Act as necessary.

3.6.2 Cabinet Committee on Sustainable Development (CCSD)

The Cabinet Committee on Sustainable Development (CCSD) was formed in early 1990 from the amalgamation of ELUC and the Cabinet Committee on Economic Development. CCSD has taken on ELUC's policy function and is responsible for formulating policies and programs which encourage comprehensive industrial and regional development in B.C., while weighing environmental concerns. CCSD is now the sponsor of review processes such as the Mine Development Review Process and the Major Project Review Process.

Two levels of committee are used in policy development: at the deputy minister level (Deputy Ministers Committee on Sustainable Development and Environment and Land Use) and at the ministerial level (CCSD). The Deputy Ministers committee has representatives from fourteen ministries including the resource ministries and others such as Municipal Affairs and Intergovernmental Affairs. This Deputy Ministers committee reviews and comments on submissions from line ministries that have implications for the economic and industrial strategies of the government, while balancing environmental concerns. Ministers from the same fourteen ministries sit on CCSD (May 1990). CCSD is chaired by the Minister of Regional and Economic Development.

When a policy issue is to be advanced to Cabinet level, the policy proposal first undergoes circulation to all ministries represented on the above two committees. This provides an opportunity for feedback and necessary revisions prior to preparation of a Cabinet submission. The Cabinet submission is first reviewed by the Deputy Minsters Committee on Sustainable Development and Environment and Land Use and, following approval, by both CCSD and Treasury Board (if funding is involved). Following approval of either or both of these bodies, the submission is then forwarded to the full Cabinet. At any stage the submission may be rejected or sent back down for revisions (May 1990).

3.6.3 B.C. Utilities Commission (BCUC)

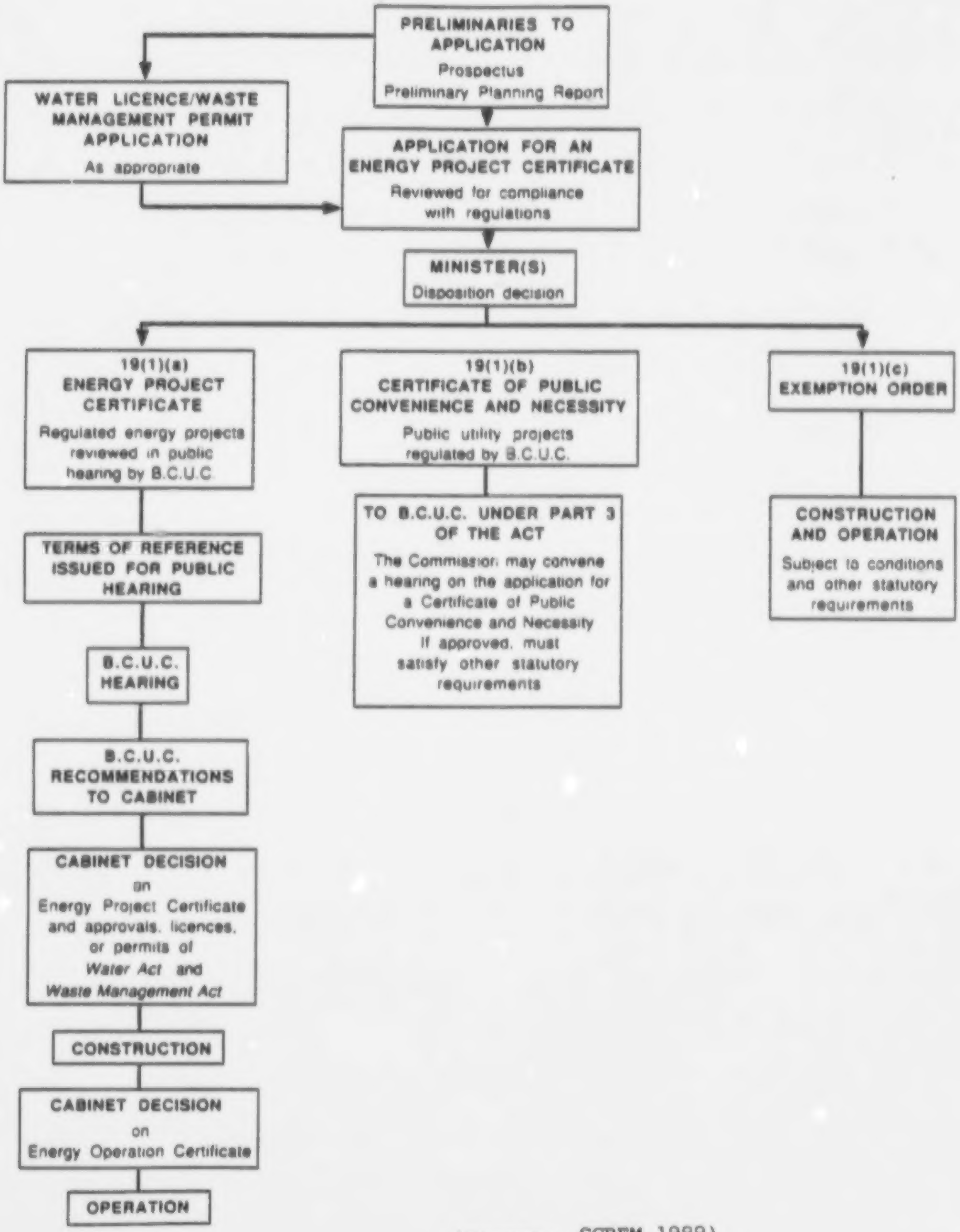
In 1980 the B.C. government enacted the Utilities Commission Act (S.B.C. 1980, c.60) which outlines responsibilities for the review of major energy projects, and establishes a comprehensive process for the review and certification of major energy projects and the removal of energy resources from B.C. While previously hydroelectric projects had been licensed under the Water Act the B.C. Utilities Commission (BCUC) now reviews energy projects in the Province. In 1981 Site C was the first large project to be examined by the Commission. Given that the allocation of lands for hydroelectric storage is a major source of land use conflict, this authority to review energy-related land uses is significant.

The Minister of MEMPR administers the Energy Project Review Process (EPRP) under the Utilities Commission Act. Concurrence of the Minister of Environment is required in decisions regarding the review of regulated projects. Before proceeding with a project, a proponent must receive an Energy Project Certificate from the Minister of MEMPR and the Minister of Environment. If an applicant is defined as a public utility under the Act, the applicant must apply for a Certificate of Public Convenience and Necessity (CCREM 1989). Applications are sent to the Minister of MEMPR who, with the Minister of Environment, refers them to BCUC for public review. These ministers also determine the terms of reference. With the concurrence of the Minister of Environment, the Minister of MEMPR may require BCUC to hold public hearings on proposals subject to the Act (CCREM 1989). An Energy Project Coordinating Committee (EPCC), consisting of representatives of BCUC, MEMPR and the Ministry of Environment, supervises three Working Groups and coordinates information flow between the proponent and government agencies. Ultimate authority lies with Cabinet.

The Energy Project Review Process (EPRP) consists of the following steps required to gain approval of an energy project (see Figure 10). A application must be made directly to the Minister of Energy, Mines and Petroleum Resources (MEMPR) to construct an energy project. The application must identify the proposal's potential environmental and directly related social implications, and plans to mitigate negative impacts and maximize positive impacts.

The process is initiated when the proponent submits a Prospectus to the Energy Project Coordinating Committee (EPCC) for referral to the Working Groups. Preparation of an Application is initiated through: discussion between the proponent or consultant and the Working Groups on siting alternatives; a benefit cost analysis; an environmental

Figure 10. Energy Project Review Process (EPRP)



B.C. ENERGY PROJECT REVIEW PROCESS: CERTIFICATION PROCEDURES.

PRELIMINARIES TO APPLICATION
Prospectus
Preliminary Planning Report
WATER LICENCE/WASTE MANAGEMENT PERMIT APPLICATION
As appropriate
APPLICATION FOR AN ENERGY PROJECT CERTIFICATE
Reviewed for compliance with regulations
MINISTER(S)
Disposition decision
19(1)(a)
ENERGY PROJECT CERTIFICATE
Regulated energy projects reviewed in public hearing by B.C.U.C.
19(1)(b)
CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY
Public utility projects regulated by B.C.U.C.
19(1)(c)
EXEMPTION ORDER
TERMS OF REFERENCE ISSUED FOR PUBLIC HEARING
TO B.C.U.C. UNDER PART 3 OF THE ACT
The Commission may convene a hearing on the application for a Certificate of Public Convenience and Necessity
If approved, must satisfy other statutory requirements
CONSTRUCTION AND OPERATION
Subject to conditions and other statutory requirements
B.C.U.C. HEARING
B.C.U.C. RECOMMENDATIONS TO CABINET
CABINET DECISION on Energy Project Certificate and approvals, licences, or permits of Water Act and Waste Management Act
CONSTRUCTION
CABINET DECISION on Energy Operation Certificate
OPERATION

(Source: CCREM 1989)

assessment; compensation or mitigation; and other information as needed. The proponent then submits an Application to the EPCC accompanied by the above prepared studies and information. Once the EPCC and Working Groups have determined that the Application complies with regulations, the Application is then submitted to the Ministers. The EPCC will also recommend a public hearing by BCUC, exemption from the Acts provisions, or rejection. The Ministers decide on EPCC recommendations (CCREM 1989).

If an Application for Energy Project Certificate (EPC) is referred to BCUC for a public hearing, the EPCC coordinates the drafting of terms of reference and presents these to the Minister for review and approval. BCUC conducts a detailed review and holds public (or confidential) hearings. Recommendations are submitted to Cabinet which may grant an EPC with terms and conditions or reject the proposal. There is no appeal for environmental permits and licenses for energy projects that have been granted EPCs. Government monitoring is coordinated by EPCC who also reports to Cabinet on proponent compliance.

If MEMPR orders that an Application be referred to BCUC as an application for a Certificate of Public Convenience and Necessity (CPCN), the BCUC review process is similar to that for an EPC except that final approval is granted by BCUC and not Cabinet, and BCUC has the discretion to hold a public hearing, but need not do so. Following a review, BCUC may grant a CPCN with terms and conditions or reject the proposal. Following approval, EPCC facilitates the proponents applications for other approvals and monitors proponent compliance with conditions during construction (CCREM 1989).

Importantly, the Ministers of MEMPR and Environment have the option to bypass the BCUC and exempt the project from the Act or reject the project outright. Any decision of the Utilities Commission can be appealed in the B.C. Court of Appeal.

3.6.4 Agricultural Land Commission

The Agricultural Land Commission is an independent Crown agency reporting to Cabinet through the Minister of Agriculture and Fisheries that deals with preservation and planning of agricultural lands on both private and Crown land. Approximately 3.7% of the provincial land base, is comprised of class 1 to 4 agricultural land (BC MoCL 1989a). Only 1.09% of B.C.'s Crown land is class 1 to 3; lands suitable to support a variety of crops (BC MoCL 1989a).

3.6.4.1 Legislation and Mandate

The Agricultural Land Commission Act (RSBC 1979) mandates commissioners appointed on recommendation of the Minister of Agriculture and Fisheries to carry out the terms of the Act. Protocols are outlined in the Agricultural Land Reserve Procedure Regulations and the Agricultural Land Commission Subdivision and Land Use Regulations. Soil removal and land fill on ALR land is strictly controlled under the Soil Conservation Act (RSBC 1979).

The primary responsibility of the Agricultural Land Commission (ALC) concerns land use matters on properties within the Agricultural Land Reserve (ALR). However, the ALC is also involved in negotiation with other ministries on lands outside the ALR. The goals of the Commission are:

1. to preserve land resources useful to British Columbia's agricultural industry;
2. to develop and encourage agricultural land use planning and farming in general through land use management; and
3. to provide associated advisory services to British Columbia's governments, the public and the farming community (BC MoCL 1989b).

3.6.4.2 Planning Process

There are four levels of authority in the ALR system: local governments such as municipalities and regional districts, the ALC, Cabinet, and the Environment and Land Use Committee (ELUC). Cabinet holds the ultimate power in land use allocation decisions. The Agricultural Land Commission is comprised of two divisions: a planning procedures and technical division and a property and soils management division, both overseen by a general manager. The Commission maintains review processes for seven types of applications: public inclusion of land (i.e., by local government or Commission); private inclusion of land (i.e., by the owner); public exclusion of land; private exclusion of land; public non-agricultural use or subdivision of land; private non-agricultural use or subdivision of land; and soil removal or fill on ALR land (Andrews and Higman 1986).

The Commission is divided into eight regions covering the entire province, each headed by a commissioner. A general manager and commissioners are appointed by the Minister of Agriculture and Fisheries and are answerable to the Minister under the Agricultural Land Commission Act. ELUC and Cabinet are ultimately responsible for recommending and drafting changes to the Commission's mandate.

The planning and processing branch of the ALC is responsible for researching all land use issues involving changes or alterations to land within the ALR. The main role of this branch is to review community plans, zoning and subdivision bylaws, transportation network plans, and Crown land plans in order to ensure that they comply with the intent of the ALC Act. The ALC reviews applications for land use, in addition to any applications for soil fill or removal on ALR lands.

Inclusion of public land begins with the adoption of a land reserve plan by the regional district, following a public hearing as specified under the Municipal Act. Almost all regional districts have adopted a land reserve plan. Completed plans are recommended by the ALC to Cabinet, with or without changes. Once the land reserve plan has been approved by Cabinet, lands may be designated to the ALR by the Commission. Cabinet may also add land to the ALR on its own initiative, or on the application of local government or the Commission, following public notice and a public hearing.

Crown lands may be excluded from the ALR by Cabinet on its own initiative, or after an application by a local government or the Commission. Cabinet may exclude the land with or without conditions. After a mandatory public hearing, the local government application is reviewed by the Commission and forwarded to Cabinet with recommendations and a report of the public hearing. Alternatively, the Commission may initiate an application for exclusion. Such an application would also be forwarded to Cabinet with its recommendations and a report of the public hearings (Andrews and Higman 1986).

Crown land within the ALR can also be used for non-agricultural uses, including subdivisions. Steps for this allocation are the same as for general exclusion of land from the ALR.

Land allocation and management decisions made by the Agricultural Land Commission can be appealed by an individual or local government if two members of the Commission grant leave to appeal, or the Minister directly allows the appeal. Section 13 of the ALC Act indicates that if the appeal is allowed, whether it was referred through the Commission or through the Minister, a formal hearing must take place on the issue. Cabinet is responsible for holding the appeal hearing and ELUC retains decision making authority.

In 1988 the leasing and sale of farmland owned by the Commission was transferred to what was then the Ministry of Forests and Lands. The Ministry of Crown Lands will not enter into any new leases, but will honour all existing lease commitments. Vacant properties are to be sold. This arrangement leaves the Commission with a small role in the allocation and management of lands, although it maintains status as a referral body for all plans affecting agricultural lands in the province. The soil conservation program remains in place affecting allocation only indirectly, by controlling soil removal or fill under the Soil Conservation Act (RSBC 1979).

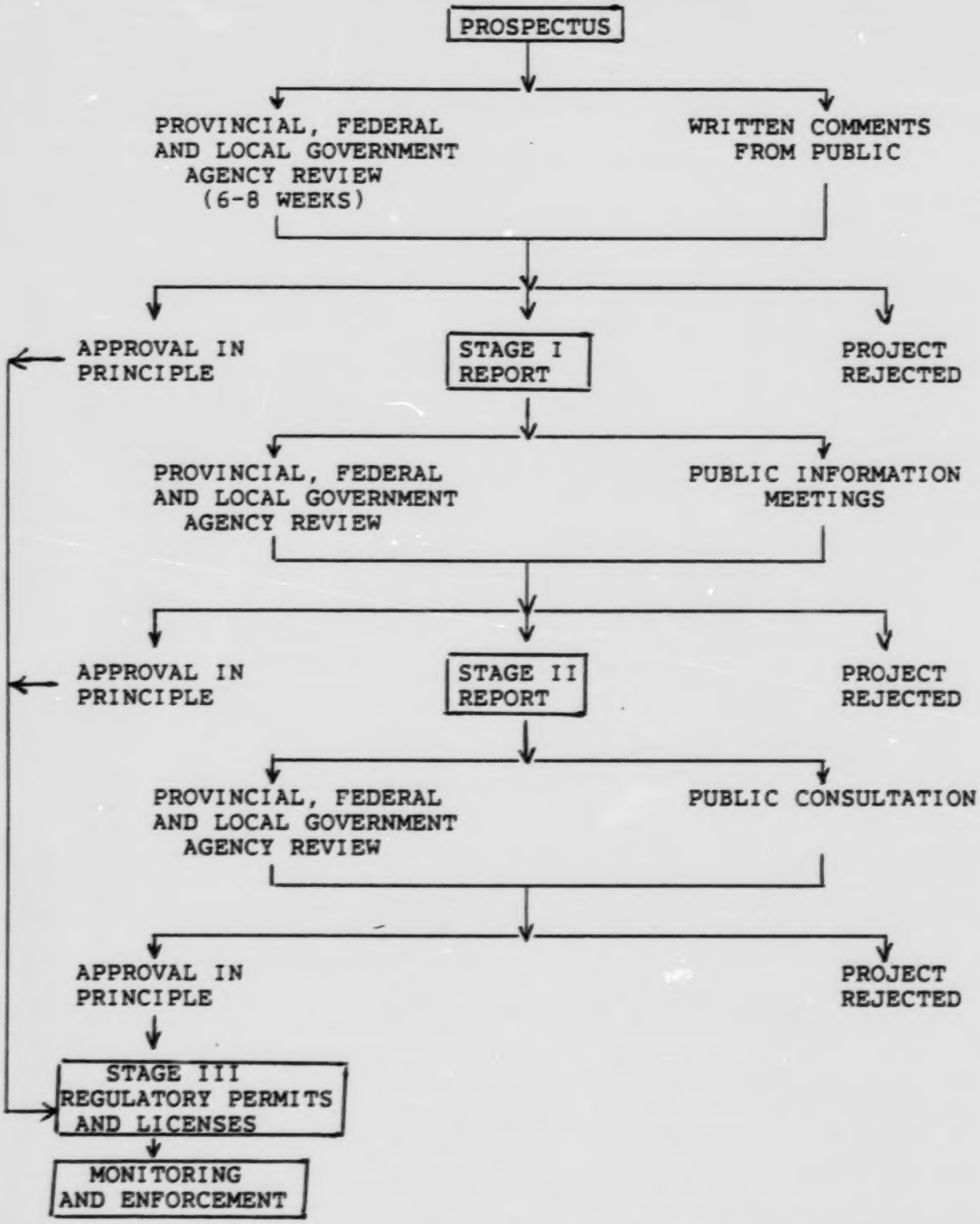
3.6.5 Major Project Review Process

The Major Project Review Process (MPRP), formally adopted by the provincial government in early 1990, was created to provide a formal assessment and referral process for projects not examined under existing reviews such as the Mine Development Review Process and the Energy Project Review Process (BC MoE and MoRED 1989). A list of industries and associated developments to which MPRP is to be applied has been created. The four main categories of development include: pulp and paper production, mineral smelting and refining, chemical production, and major ports and marinas (BC MoE and MoRED 1989). While MPRP is intended to cover only projects with suspected high environmental impacts, the Cabinet Committee on Sustainable Development (CCSD) can request a project undergo review at its discretion.

The MPRP is a non-legislated working policy supported by the Environment and Land Use Act. It is administered by the Major Project Steering Committee (MPSC) and co-chaired by the Ministry of Regional Economic Development (MoRED) and the Ministry of Environment (MoE). The Steering Committee is comprised of representatives from MoE, MEMPR, Municipal Affairs, Recreation and Culture, and Environment Canada and the Federal Environmental Assessment Review Office (FEARO). FEARO and Environment Canada suggest means of achieving Federal Environmental Assessment and Review Process requirements. Other ministries may be contacted as interests and jurisdictions dictate. The MPRP Policy outlines many of the provincial statutes and associated provincial ministries, and federal statutes which are potentially applicable to MPRP. The list includes the Agricultural Land Commission Act, the Fisheries Act (Canada) and the Land Act.

MPRP has a three step process outlined in Figure 11. If the prospectus is approved, a lead agency is established by MPSC on the basis of the project type and the nature of its major anticipated impacts (BC MoE and BC MoRED 1989). Municipal and/or regional levels of government in the affected area are also invited to participate at this point. MPSC must grant approval-in-principle (AIP) prior to issuance of provincial permits or licenses. If a project has been required to undergo stage II, the CCSD must make the AIP decision. AIP is valid for five years and will lapse if CCSD determines that significant progress has not been made in implementing the project. A confidential financial feasibility analysis may be required at any time in the process. MoRED advises the Steering Committee on the financial acceptability of the project.

FIGURE 11
MAJOR PROJECT REVIEW PROCESS


PROSPECTUS
PROVINCIAL, FEDERAL AND LOCAL GOVERNMENT AGENCY REVIEW (6-8 WEEKS)
WRITTEN COMMENTS FROM PUBLIC
APPROVAL IN PRINCIPLE
STAGE I REPORT
PROJECT REJECTED
PROVINCIAL, FEDERAL AND LOCAL GOVERNMENT AGENCY REVIEW
PUBLIC INFORMATION MEETINGS
APPROVAL IN PRINCIPLE
STAGE II REPORT
PROJECT REJECTED
PROVINCIAL, FEDERAL AND LOCAL GOVERNMENT AGENCY REVIEW
PUBLIC CONSULTATION
APPROVAL IN PRINCIPLE
PROJECT REJECTED
STAGE III REGULATORY PERMITS AND LICENSES
MONITORING AND ENFORCEMENT

(Source: BC MoE and MoRED 1989)

Public involvement is mandatory in the policy statement. Copies of documents prepared for the prospectus and Stage I must be made available to local governments, native groups, public libraries, and others as directed by the Steering Committee. Availability of these documents must be advertised in local papers and public comments are to be invited for submission within thirty days of the newspaper advertisement. At Stage I, a public information session is also required to solicit feedback on the project proposal, and the proponent must forward all resulting comments to the MPSC. The Steering Committee dictates the form and location of public sessions. If a Stage II is required, public involvement may further be required by the CCSD in one of three ways:

1. fact-finding mission to verify and/or supplement existing information;
2. mediator/facilitator to meet separately with affected parties to find a mutually acceptable solution;
3. public hearings by panel selected by the CCSD.

The CCSD has discretion to make decisions regarding public input and the extent to which input is incorporated into the final decision.

4.0 CONCLUSIONS

This paper has reviewed the evolution of Crown land allocation and management in British Columbia since the Second World War, and chronicled the development of the agencies which currently administer 95% of this province. Through a review of the legislative mandates, organizational structures and planning processes of these various ministries and agencies, it is evident that the administration of Crown lands in B.C. is accomplished through a complex institutional structure. During the evolution towards the current array of ministries and related agencies, policies and procedures have developed in a variety of ways in response to changing societal interests. The nature of land allocation and resource management has also evolved in a variety of ways. Given the current level of debate and conflict over the allocation and management of British Columbia's land and resources, this is an appropriate time for an institutional review in order to best respond to these problems.

REFERENCES

Andrews, W.J. and J.W. Higman. 1986. Protecting the B.C. Environment: A Catalogue of Project Review Processes. Edited by R.L. Sherwood. Environmental Protection, Conservation and Protection, Environment Canada. Vancouver: Environment Canada.

British Columbia. 1979a. Agricultural Land Commission Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979b. Ecological Reserves Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979c. Environment and Land Use Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979d. Forest Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979e. Land Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979f. Ministry of Forests Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979g. Park Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1979h. Range Act. Revised Statutes of British Columbia, Victoria, B.C.

British Columbia. 1980. Utilities Commission Act. Statutes of British Columbia, Victoria, B.C.

British Columbia. 1981. Environment Management Act. Statutes of British Columbia, Victoria, B.C.

British Columbia. 1982. Wildlife Act. Statutes of British Columbia, Victoria, B.C.

British Columbia. 1988. Mineral Tenure Act. Statutes of British Columbia, Victoria, B.C.

British Columbia. Ministry of Crown Lands (BC MoCL). 1988. Crown Land Policy Summary. Victoria, B.C.

British Columbia. Ministry of Crown Lands (BC MoCL). 1989a. British Columbia Land Statistics. Victoria, B.C.

British Columbia. Ministry of Crown Lands (BC MoCL). 1989b. Crown Land Administration Principles. Occasional Paper No.7. Victoria, B.C.: Land Policy Branch.

British Columbia. Ministry of Energy, Mines and Petroleum Resources, Mining and Inspection Branch. (BC MEMPR) 1989a. British Columbia Guidelines for Mineral Exploration. Victoria, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources, Mine Development Steering Committee (BC MEMPR) 1989b. Mine Development Review Process: An Overview. Victoria, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. (BC MEMPR) 1990a. Coordinated Mine Development Review in British Columbia: A Historical Perspective. Victoria, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. (BC MEMPR) 1990b. Bill 59: The Mine Development Assessment Act: Rationale and Provisions. Victoria, B.C.

British Columbia. Ministry of Environment. (BC MoE) 1990. Meeting the Challenges of the 90's. Victoria, B.C.

British Columbia. Ministry of Environment and Ministry of Regional and Economic Development (BC MoE and MoRED).. 1989. Major Project Review Process Guidelines. Victoria, B.C.

British Columbia. Ministry of Forests. (BC MoF) 1981. Public Involvement Handbook. Queen's Printer, Victoria.

British Columbia. Ministry of Forests. (BC MoF) 1983. Forest Planning Framework. Victoria, B.C.

British Columbia. Ministry of Forests. (BC MoF) 1984a. Forest and Range Resource Analysis. Victoria, B.C.

British Columbia. Ministry of Forests. (BC MoF) 1984b. "Chapter Two: Public Involvement Resource Planning Manual." In: British Columbia Ministry of Forests, 1981. Public Involvement Handbook. Queen's Printer, Victoria.

British Columbia. Ministry of Forests. (BC MoF) 1985. Resource Planning Manual. Victoria, B.C.

British Columbia. Ministry of Forests. (BC MoF) 1989. Managing Wilderness in Provincial Forests: A Policy Framework. Integrated Resources Branch, Recreation Section. Victoria, B.C.

British Columbia. Ministry of Forests. (BC MoF) 1990. DRAFT Chapter 3. "Resource Management Plans for Timber Supply Areas." Victoria, B.C.

British Columbia. Ministry of Forests and Lands. 1987. Forest tenures: licenses and permits for harvesting timber in British Columbia. Victoria, B.C.

British Columbia. Ministry of Parks. (BC MoP) 1990a. Striking the Balance. B.C. Parks Policy. Victoria, B.C.

British Columbia. Ministry of Parks. (BC MoP) 1990b. Preserving our living legacy: Parks Plan 90: Special Features for BC Parks. Victoria, B.C.

Canadian Council of Resource and Environment Ministers (CCREM), 1989. Environmental Assessment in Canada: 1988 Summary of Current Practice. Edited by William J. Couch. FEARO: Ministry of Supply and Services, Canada.

Crook, Ray. 1990. Ministry of Energy, Mines and Petroleum Resources. Personal Communication. September 1990.

Day, C. 1987. "Regulating Coal Development: The British Columbia Experience." In IAIA, 1987. Proceedings of the International Workshop on Impact Assessment for International Development. May 31 - June 4, 1987. Barbados, West Indies. pp. 692-711.

Dellert, Lois. 1990. Manager, Forest Productivity and Decision Aids, Research Branch, Ministry of Forests. Personal communication. July 1990.

Dellert, L. 1987. "B.C.'s experience with FORPLAN." IN Hoekstra, T.W. et.al.(eds.) FORPLAN: An Evaluation of a Forest Planning Tool. Proceedings of a Symposium. November 4-6, 1986. Denver, Co. USDA Forest Service General Technical Report RM-140. pp.68-72.

Heayn, B. 1977. Integrated Resource Management: B.C.'s Regional Resource Management Committees. Masters Thesis. SCARP, UBC: Vancouver.

Ince, J.G. and G.M. Edwards. 1984. Environmental Law: British Columbia Handbook. West Coast Environmental Law Association. Vancouver: Butterworth and Co. (Canada) Ltd.

Ince, J.G. and Z.M. Pereboom. 1984. Land Use Law: British Columbia Handbook. West Coast Environmental Law Association. Vancouver: Butterworth and Co. (Canada) Ltd.

Macenko, S.L. and V.P. Neimanis. 1983. An Overview of Crown Land Management in Canada. Working Paper No. 27. Land Policy and Research Branch, Lands Directorate, Environment Canada.

May, Nicholas. 1990. Secretary, Cabinet Committee on Sustainable Development. Personal communication. July 1990.

Munn, Bill. 1990. System Planning Coordinator, Planning and Ecological Reserves Ministry of Parks. Personal Communication. October, 1990.

Niezen, A. 1989. Integrating Forestry and Wildlife Management Through Forest Management Planning in British Columbia. Masters Thesis. School of Community and Regional Planning, UBC.

Niezen, Al. 1990. Forestry Analyst, Integrated Resources Branch, Ministry of Forests. Personal communication, July 1990.

O'Gorman, Dennis. 1990. Director, Policy and Planning, Ministry of Forests. Personal communication. July 1990.

O'Riordan, J. 1976. "Approaches to Land Use Planning in British Columbia." Presented to Panel on Land Management. Pacific North West Regional Economic Conference. Victoria, B.C. May 1976.

O'Riordan, J. 1987. "Mining and Wilderness Protection." Unpublished Paper.

Pearse, P. 1976. Timber Rights and Forest Policy in British Columbia: Report of the Royal Commission on Forest Resources. Queen's Printer: Victoria.

Ringstad, Norm. 1990. Manager, Mine Development Review Process, Ministry of Energy, Mines and Petroleum Resources. Personal Communication. October 1990.

Sieffert, Bruce. 1990. Manager, Resource Planning, Integrated Resources Branch, Ministry of Forests. Personal communication. July 1990.

Vance, J. E. 1990. Tree Planning: A Guide to Public Involvement in Forest Stewardship. B.C. Public Interest Advocacy Centre: Vancouver.

Ward, E.N. 1976. Land Use Programs in Canada: British Columbia. Land Use Planning Branch, Lands Directorate, Environment Canada, Ottawa.

Williams, D.H. and Associates Ltd. 1989. TSAS-II The Revised Timber Supply Analysis System: A Description of the Analysis Procedures and System Components. prepared for Lois Dellert, Manager, Resource Analysis, Integrated Resources Branch, BC Ministry of Forests. December 1989.

Williams, D.H. 1989. AFIRM: The Analysis Framework for Integrated Resources Management. Basic Concepts. Ministry of Forests Inventory Branch, Victoria, B.C. Unpublished Report.

APPENDIX 1

TECHNICAL METHODS USED IN FOREST RESOURCE MANAGEMENT AND PLANNING

The Ministry of Forests (MoF) uses the forest planning framework discussed in Section 3.1 above to conduct integrated resource planning. In the production of resource management plans, and resource development and operational plans, a number of analytical techniques are used. This appendix addresses the mechanisms used to implement the planning process at these three levels. As most of the planning effort is focussed on the forest management planning level, this discussion reflects that emphasis.

A number of planning steps and analytical tools are used in the preparation of TSA resource management plans and TFL Management and Working plans. Steps used in TSA resource management plan preparation are briefly discussed to illustrate how land use allocation and management decisions are made and how resource conflicts are dealt with.

The MoF is in the process of preparing an Analytical Framework for Integrated Resource Management (AFIRM). This framework will provide a comprehensive analytical framework for integrated resource management. As well, a revised timber supply analysis system (TSAS-II) which will address a number of issues and concerns not dealt with in TSAS-I is in the developmental stage. The linear programming model MUSYC is used in the current timber supply analysis system. FORPLAN is another form of linear programming utilized in the United States. These models are also briefly discussed in this appendix.

A. Resource Management Planning Steps

Currently, the resource management planning process is undergoing revisions. The (draft) revised Chapter three of the Resource Planning Manual (BC MoF 1985), outlines the steps used in the preparation of TSA resource management plans. These steps are briefly reviewed.

A.1 Organization and Terms of Reference

Terms of reference are determined by the planning committee. At this stage, membership is organized, issues to be addressed are documented, information needs are determined, steering committees and working groups are formed, initial integrated resource use options are identified, analysis procedures are identified, and a work schedule is established for plan participants.

Issue identification involves identifying known or anticipated problems and perceived opportunities associated with the management of timber, range and recreation resources. Preliminary Resource Emphasis Areas (REAs) may be used in the identification of issues (which may be of a social or technical nature).

Terms of Reference are reviewed by the TSA Steering Committee and other committees dealing with the TSA, referred to Integrated Resources Branch and Inventory Branch, and made available to other agencies and the public (BC MoF 1990).

A.2 Information Assembly

Information assembly involves the systematic identification and synthesis of forestry and other data, and research needs to generate required data.

Resource Emphasis Areas composed of a number of "planning cells" are identified at this stage. REAs provide a framework for more site-specific resource use decisions at more local levels of planning. Inventory data is compiled and geographically referenced using these planning cells. REA maps are classified using a three tier classification system as a "major use," "major secondary use" or "other important secondary use".

REAs are used in the definition of inte[illegible]ted resource use options for the TSAs, identifying alternate land use allocations and management intensities.

A.3 Development and Analysis

A number of feasible management options are generated by the planning committee in this stage. "The purpose of these options is to assess the implications of:

- alternative resource use allocations that indicate basic differences in resource management emphasis;
- investment levels for resource development; and
- production requirements to meet industrial needs" (BC MoF 1990).

Attention is focussed on decisions about land allocation and management intensity rather than site-specific problems. Options are defined to reflect "alternative futures" and should reflect identified issues. A baseline option representing the historical or present ("status quo") situation is also included for comparison with other options.

The options generated are then reflected as adjustments to the productive forest land base in the timber supply analysis. A number of computer optimization models are used to analyse timber supplies. (These are briefly discussed in Sections C and D which follow). Models are used to identify timber production associated with each option and to forecast timber volumes in the future.

Both a range and recreation analysis are conducted at this stage as well. Supply targets for range are expressed in availability of forage and Animal Unit Months (AUMs) of forage. Recreation options are expressed in terms of their ability to meet such factors as Recreation Opportunity objectives (ROS), and Satisfactory User Day Opportunities (SUDOs), and Visual Quality Objectives (VQOs). Analysis is provided for other non-timber resources by appropriate resource agency staff in consultation with Forest Service Regional or District Planning staff (BC MoF 1990).

A.4 Evaluation of Options

At this stage, identified issues are addressed and the implications of each option are determined. A matrix format is used to assess the options against production goals. A resource impact matrix, program impact matrix and/or a goal achievement matrix may be used (see Figure 12).

On the basis of these evaluations the Planning Officer (or District Manager), Forest Service staff and the planning committee select and recommend "the integrated resource use option which they feel merits further consideration in resource management plan development" (BC MoF 1990).

An Options Report presenting the set of integrated resource use options which have been selected is submitted to the Chief Forester before being released to the public. Feedback is solicited from Forest Service staff, the public, other agencies and the forest industry. Following a review of the feedback and consultations with the planning team, the Regional Manager chooses an option and makes a recommendation to the Chief Forester.

A.5 Option Selection and Plan Development

Following a public review of the Options Report, the Chief Forester decides on a management option. In arriving at a decision, consideration is given to the target AAC and management objectives. In order that the Chief Forester can make an overall evaluation of the analysis, consultation is sought from the Integrated Resources Branch, other resource agencies, other interest groups and the general public. A Rationale Report is produced documenting the resource management decisions and their rationale. Conditions and assumptions are outlined and a revised timber supply forecast is provided.

A Draft Resource Management Plan is then prepared detailing the preferred management option and the associated AAC, range and recreation targets, and summarizing the decisions and recommendations made in the plan's development. These form the basis for the development of operational details of the plan. Subsequent planning activities and decisions outline how the production targets will be met and guidelines and management prescriptions are provided. Responsibilities for implementation are also defined. The draft plan is then reviewed by the public, other agencies and the TSA Steering Committee. With feedback from this review, the Regional Planning

Figure 12. Matrices used in Timber Supply Analysis System (TSAS)

OPTION EVALUATION MATRIX

OPTION	RESOURCE					
	Timber	Range	Recreation	Wildlife	Water	Fish
Status Quo (present management)	AAC (m^3)	AUMs	SUDOs	0	0	0
Modest Enhancement	AAC (m^3)	AUMs	SUDOs	+	+	-
Major Enhancement etc.	AAC (m^3)	AUMs	SUDOs	++	-	+

Ratings

++	very positive impact
+	positive impact
0	no impact
-	negative impact
--	very negative impact

AAC= Allowable Annual Cut
AUM= Animal Unit Months
SUDO= Satisfactory User Day Opportunities

PROGRAM IMPACT MATRIX

OPTION	COST IMPACT					
	Timber	Range	Recreation	Wildlife	Water	Fish
Status Quo	AAC	AUMs	SUDOs	...		
Cost	$x	$y	$z	...		
Option 1	AAC	AUMs	SUDOs	...		
Cost	$$x_1$	$$y_1$	$$z_1$	...		
Option 2	AAC	AUMs	SUDOs	...		
Cost Etc.	$$x_2$	$$y_2$	$$z_2$	...		

(Source: BC MoF 1990)

Officer or District Manager coordinates the preparation of a revised Resource Management Plan.

Apportionment of the AAC is a process conducted parallel to the resource management planning process and apportionment options are prepared by the Regional Manager for coordination and evaluation by the Timber Harvesting Branch. Apportionment is approved by the Minister rather than the Chief Forester.

Licensees identify their 20-year timber supplies for approval. A supplement to the Resource Management Plan, the 20 Year Operating Plan, identifies these supply areas. This plan locates and maps available mature timber consistent with the REA map and the AAC decision.

Once approval is provided by the Chief Forester for the Resource Management Plan, the Forest Service proceeds to develop local resource use plans and resource development plans consistent with the objectives and standards outlined in the plan.

A.6 Implementation, Monitoring and Revision

TSA plans are implemented at the district level by District Managers and licensees. These plans are then used in the preparation of district annual programs and Local Resource Use Planning.

Both plans and inventories are monitored at the District and Regional level. Decisions at the local resource use planning level are compared with the assumptions used in the Resource Management Plans. Audits are conducted by regional staff to ensure that the plan is being used in District decision making.

District inventory base maps are updated for fire, pest, logging and silvicultural activities. This information is forwarded to the Inventory and Silviculture Branches to update their data bases and for use in reviewing Resource Management Plans. District Range and Recreation inventories are also kept updated. Resource Management Plans for TSAs are normally revised every 5 years, but may be revised sooner in the event of major changes (eg. fire, pests, etc.).

The above process is the most current version of planning at the resource management level. While the process has been discussed here in the context of planning for TSAs, the Forest Service is developing a similar process for TFLs. Planning for TFL M&WPs will then be based on Resource Emphasis Maps as well (Niezen 1990).

B. AFIRM

The Analytical Framework for Integrated Resource Management (AFIRM) is a comprehensive analytical framework for integrated resource management on TSAs that is currently being developed by the Forest Service. The objective of AFIRM is "to determine and quantify the implications of all resource management options that have been developed for a TSA"

(Williams 1989). As a conceptual framework, AFIRM will coordinate the analysis of all the resources of a TSA through the use of a georeferenced data base, a generalized process of resource land base allocation and projection, and a set of management options which pertain to all of the resources on the TSA (Williams 1989) (see Figure 13). This system will allow geographically based information to be considered in yield analysis (AAC calculation) thus moving from the use of aggregated information to spatially disaggregated information.

AFIRM relates to four steps of the TSA planning process: development of management options, analysis of each option (through AFIRM), selection of an option, and development of the Resource Management Plan for the TSA.

Each management option developed in the planning process would be analysed through AFIRM to determine and quantify for each resource on a TSA: the allocation of land to that resource (i.e the resource land base); development guidelines; a development schedule; production targets (e.g. AAC, AUMs, Visitor Days, etc.); and management strategies (e.g. prescribed burns for wildlife, silviculture, or improved utilization, etc.) (Williams 1989).

As a framework, and not a tool or model, AFIRM will allow other agencies and stakeholders to participate in the identification of planning units, data to be considered, and so on. With timber supply analysis conducted as a component of AFIRM, this approach will allow all agencies to participate fully in the identification of issues and options. In additioh, this component approach would prevent any one agency from dominating the process.

This framework is still largely at the conceptual stage and will likely take a number of years to implement (Dellert 1990). In order for this framework to be implemented, several developments are necessary. Firstly, consensus must be reached on the planning units to be considered (the "planning cells"). Current planning approaches are strata based and not spatially based. Spatial analysis using georeferenced data is a prerequisite of AFIRM.

Secondly, an integrated georeferenced data base of all the resources of the TSA land base and a geographic information system to access and analyze this data is necessary. While the inventory for timber resources is extensive, inventory information for non-timber resources is still limited. Therefore, data must be collected for all resources. Thirdly, data standards must be set so that data are transferable and consistent. Efforts have been made to acquire converted TFL data from licensees so that the Crown has a full data set for the province (Dellert 1990).

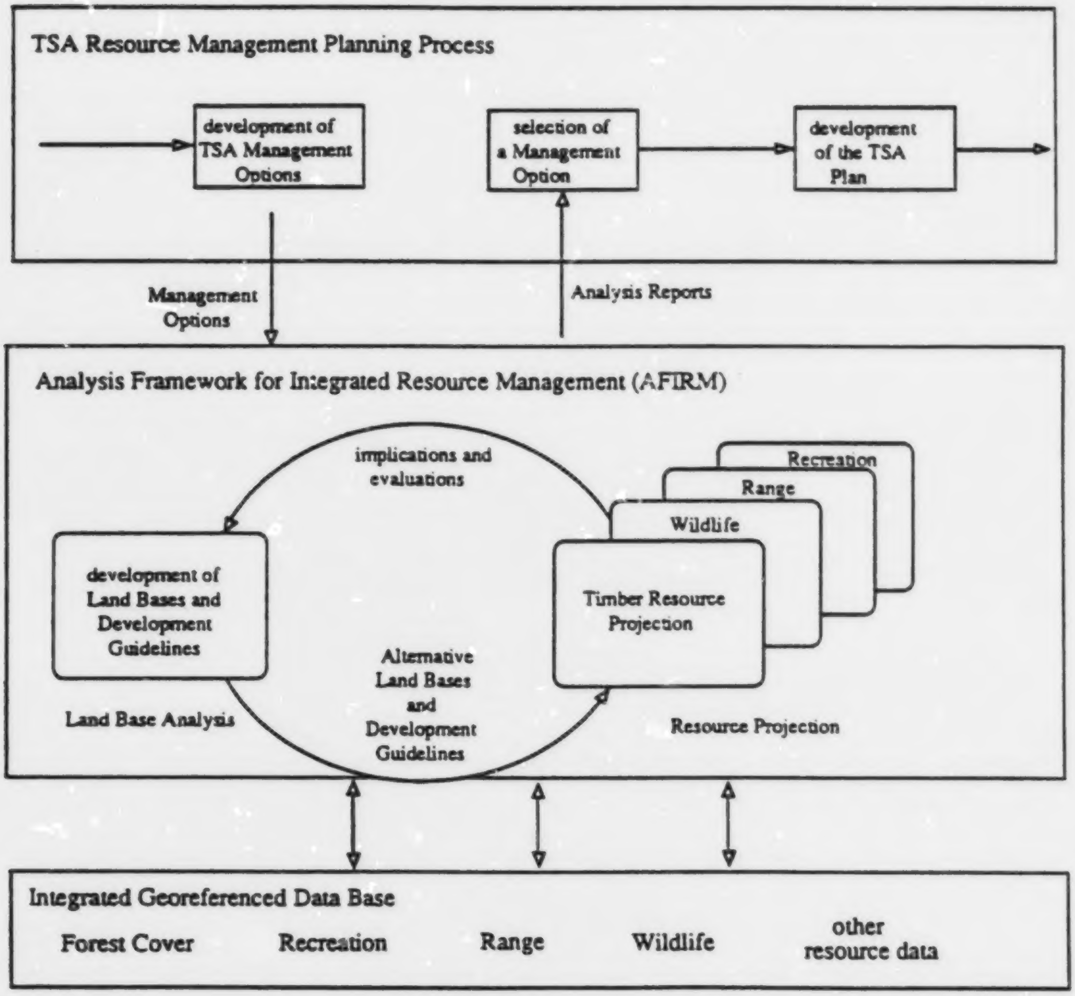
C. Timber Supply Analysis Systems

Timber Supply Analysis is the process of identifying and quantifying the implications for the timber resource of alternative resource

Figure 13. A Framework for Integrated Resource Management (AFIRM)

Ministry of Forests
Inventory Branch

September, 1989


TSA Resource Management Planning Process
development of TSA Management Options
selection of a Management Option
development of the TSA Plan
Management Options
Analysis Reports
Analysis Framework for Integrated Resource Management (AFIRM)
implications and evaluations
development of Land Bases and Development Guidelines
Recreation
Range
Wildlife
Timber Resource Projection
Alternative Land Bases and Development Guidelines
Land Base Analysis
Resource Projection
Integrated Georeferenced Data Base
Forest Cover
Recreation
Range
Wildlife
other resource data

(Source: Williams 1989)

The Analysis Framework for Integrated Resource Management
AFIRM supports the TSA Resource Management Planning Process, and in turn is dependent upon an Integrated Georeferenced Data Base.

management options proposed for a TSA. The procedures, data and computer systems used to perform this analysis comprise the Timber Supply Analysis System (TSAS). TSAS has been revised recently to address emerging issues which were inadequately treated in the original version. For example integrated resource management issues being dealt with today are area-specific in nature while the analytical methods used in TSAS-I are not (Williams and Assoc. 1989).

TSAS-I has a strata-based view of forest inventory data which does not utilize area-based technology made available with geographic information systems. TSAS-I is used to determine sustainable harvest levels (long term sustained yield) and operational feasibility. The current system has emphasized long term analysis to establish "bounds" within which short term allocation problems are solved. The linear programming model, MUSYC (multiple use sustained yield calculation) is one of the tools that has been used in TSAS-I (see Section D.1).

The revised TSAS-II uses area-based analysis. It supports both long term and short term planning functions but focuses primarily on short term planning problems such as determining 20-year harvest schedules which can be identified geographically.

TSAS-II would function as a step under AFIRM. In doing so, it would quantify for each TSA Management Option:

- the Timber Harvesting Land Base,
- timber harvesting guidelines,
- management schedules,
- feasible harvest rates and Long Run Sustained Yield, and
- the allocation of feasible 20-year operating areas to the licensees operating on a TSA (Williams and Assoc. 1989).

The analysis of timber supply with TSAS-II involves six steps:

1) determination of analysis procedures and data requirements,
2) acquisition of data,
3) land base analysis,
4) short term timber allocation and scheduling,
5) long term sustained yield analysis, and
6) analysis of the timber harvesting and management implications of the selected Management Option.

As part of the Resource Management Planning process, determining analysis procedures and data requirements (step 1) assists in the development of management options. Through this process, Timber Projection Strategies are identified to support various management options. Data necessary to undertake these projections are subsequently acquired (step 2).

The Land Base Analysis (step 3) is a cooperative process involving all of the resource agencies participating in TSA planning. The objective of this process is to identify resource land bases and develop guidelines for each TSA management option consistent with the intent of the management option, and encode them in a georeferenced database.

Land Base Analysis consists of four processes: the overlaying of various resource themes to identify resource interactions, the resolution of these interactions by specifying resource guidelines, the application of the guidelines to the composite resource theme to identify the Timber Harvesting Land Base, and the economic assessment of the Timber Harvesting Land Base to identify the economically operable land base (Williams and Assoc. 1989).

The objective of the allocation and scheduling process (step 4) is to provide a systematic and consistent method of determining equitable operating areas for licensees on the TSA. The objective of short term timber allocation is to identify a supply of timber for each licensee that is operationally feasible, sufficient to last 20 years at the current rate of harvest and economically feasible for the licensee.

The objectives of the Long Term Sustained Yield Analysis (step 5) are to determine:

- the level of harvest that can be supported for each Timber Harvesting Land Base developed in the Land Base Analysis;
- the extent to which this level can be increased through specific management programs, and
- the impact of short-term allocation and scheduling on the mid- and long-term timber supply (Williams and Assoc. 1989).

Timber Supply Scenarios are developed from the Resource Projection Strategies to explore management options incorporating: the Timber Harvesting Land Base, the Timber Harvesting Guidelines, and timber management guidelines such as utilization level, silvicultural treatments, budget constraints, harvesting objectives, species-specific harvest requirements, and a harvest flow policy (Williams and Assoc. 1989).

Two standards scenarios are always included in the set developed for each TSA: the Current Plan Scenario (or AAC Rationale), based on the management option selected by the Chief Forester during the planning cycle, and the Current Performance Scenario (or Status Quo) which assumes the continuation of basic silviculture and timber management practices experienced on the TSA over the previous five years. Alternative Timber Supply Scenarios are also developed to determine the implications of each management option with respect to a variety of timber supply issues (e.g. silviculture, protection and utilization) (Williams and Assoc. 1989).

Scenario testing is conducted with both simulation and linear programming models. The Simulation Model of Timber Supply (SMTS) is used to determine the implications of a schedule of harvest and management assumptions for a TSA over a 200-year projection period. The goal of this exercise is to determine, for each scenario, the sustainability of current harvest levels and the long run sustainability of the timber resource.

Testing with a linear programming model (MUSYC is currently used (see Section D.1)) permits the analysis of scenarios as part of the formal analysis in 5-year planning. This process can also produce harvest schedules and construct management programs that are optimal with respect to a specified management objective. While scenario testing with a simulation model is expected to be conducted at the regional or district level, modelling with a linear programming model is carried out by the Analysis Section of Integrated Resources Branch.

D. Forestry Planning Models

Timber Supply Analysis is conducted at the forest management planning level. As discussed in Section B and C above, this is where the majority of analytical effort is focussed. Computer models are used at this level to conduct timber supply analyses for TSAs and to review TFL management working plans prepared by TFL licensees.

Timber supply analysis is used as the basis for setting harvest rates for TSAs and TFLs, and is itself based on a forecast of timber supplies using forest planning models for various proposed integrated resource management options. These options are considered by the Chief Forester in the consideration of harvest rates.

D.1 MUSYC

Multiple Use Sustained Yield Calculation (MUSYC) is the Ministry's base forest planning model. Timber supply forecasts for the Status Quo Option (the option that models current practices and programs) and the AAC Rationale Option (documentation of the assumptions made in setting the AAC) are generated using this model.

MUSYC is a linear programming harvest scheduling model developed in the 1970s by the US Forest Service. MUSYC involves the selection of a combination of activities which maximize or minimize an objective while satisfying constraints. The objective used in the Status Quo and AAC Rationale Options is the maximization of volume harvested over the planning horizon. A variety of constraints can be specified to place limitations on the selection of activities. Through examination of different combinations and levels of constraints, managers can generate and evaluate different scenarios.

MUSYC is typically used to assess the following issues (BC MoF 1985):

- the harvest which is possible over time for a specified level of funding;
- the silviculture regimes which will maximize volume harvested; and

- the level of silviculture funding which is required to maintain or achieve a specified rate of harvest.

MUSYC produces reports which describe the periodic harvest, management activities and the residual growing stock.

D.2 FORPLAN

FORPLAN was developed in the late 1970s for the US Forest Service in response to the adoption of the National Forest Management Act in 1976 which required the Forest Service to become more explicit regarding land use.

FORPLAN is different than other models such as MUSYC because it incorporates timber harvesting into land management planning rather than merely addressing questions of physical and biological sustainability of harvest levels. This model is a multi-resource scheduling model rather than a harvest scheduling model. The output is a land allocation strategy rather than a timber harvesting strategy (BC MoF 1985).

The Ministry of Forests has had a copy of the FORPLAN model for a number of years and has evaluated its potential application in BC. However, the Ministry does not plan to use FORPLAN for the following reasons:

1) BC's land management and resource planning requirements are different;

2) BC has chosen a "component approach" to modeling rather than using a single large model; and

3) given the priority on resource planning in BC, resources are not available to implement FORPLAN (Dellert 1987).

In deciding to pursue a "component approach" to modeling, BC has focussed on a planning framework in which several models, processes or systems provide support for decision making. These components span several levels of planning and provide the ability to assess many resource use and timber issues. Therefore, the focus is on the planning process, not on a planning model (Dellert 1987).

MULTIPLE ACCOUNTS ANALYSIS AND EVALUATION OF FOREST LAND USE CONFLICTS

Background Study for the
Forest Resources Commission

by

T.I. Gunton
G.C. Van Kooten
S. Flynn

6 March 1991

Multiple Accounts Analysis

1.0 Introduction

Allocating forest land in British Columbia involves tradeoffs between conflicting values. These conflicts are often assessed by benefit-cost analysis which reduces tradeoffs to monetary units which can be compared in a single index. The background studies by Vertinsky, Stanbury and Thille (1990), and Gunton (1990) indicate that benefit-cost has made enormous strides forward in its ability to assess tradeoffs involving intangibles such as wilderness values which are difficult to measure. Nonetheless, many variables of significance to decision makers such as environmental impacts and job creation are either excluded from benefit-cost analysis or concealed in the analysis.

The purpose of this background study is to review a technique termed multiple accounts analysis (MAA). MAA was developed to overcome the deficiencies of benefit-cost analysis by extending the analysis to include all important variables in an explicit and visible way. The review will begin with a discussion of the origin of multiple accounts, and the current practice of multiple accounts assessment. A case study will be used to illustrate the application of multiple accounts in forest land use planning.

2.0 Origin of Multiple Accounts

In October 1961, the U.S. Secretaries of the Interior, Agriculture, Army, and Health, Education and Welfare were requested to review evaluation standards for the use and development of water and related land resources, and to recommend improvements. On May 15,1962 the report "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources" was approved and published as Senate Document No. 97, 87th Congress, Second Session. This report recommended that development, environmental preservation, and well-being of people be considered equal objectives. However, plans were to be formulated on the basis of economic benefits and costs and then constrained by environmental preservation and social well-being objectives. The result was that preservation and well-being were not given equal consideration with development (O'Brian 1977 p.2). The U.S. Water Resources Council subsequently undertook the development of a set of principles and standards for planning water and land resources which attempt to treat social and environmental considerations with the same weight accorded economic variables. Their recommendations, set forth in the Report to the Water Resources Council by Special Task Force: Procedure for Evaluation of Water and Related Land Resource Projects (1969), consisted of a system of multiple accounts for assessing projects and plans.

Multiple accounts analysis was thus first officially promulgated by the U.S. Water Resources Council (WRC) on October 25th, 1973 when the WRC's Principles and Standards for Planning Water and Land Related Land Resources (1973) became effective under the authority of the Water Resources Planning Act of 1965. This represents the first attempt to formalize the application of multi-objective planning methodology to the management of water resources (O'Brian 1977 p. 4). The methods were revised in 1979 and subsequently referred to as the "Principles, Standards, and Procedures" (PS&P) (Deason 1982 p. 39) after 1980. However, the PS&P were repealed in 1982, and then reincarnated in 1983--albeit downgraded to the status of "Guidelines" (Grigg 1985 p. 80-83). The 1983 incarnation, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G), is currently in use.

3.0 Multiple Accounts Analysis

The multiple accounts method is based on the assumption that economic, social and environmental factors should be given equal consideration in project evaluation. It was recognized, however, that these factors cannot be effectively integrated into one evaluative framework such as a benefit-cost analysis. consequently, the U.S. Water Resources Council proposed the creation of four separate accounts to analyze proposed project impacts on the economy, environment and social well being. The four accounts currently utilized are:

1) National Economic Development Account (NED)
2) Environmental Quality Account (EQ), Regional
3) Economic Development Account (RED) and
4) Other Social Effects Account (OSE)

3.1 National Economic Development Account (NED)

The NED account is in essence a traditional benefit-cost analysis designed to identify the plan with the greatest net economic benefit to society. This account has several limitations which necessitate the use of other evaluation accounts.

One key limitation is that it is not possible to place an appropriate dollar value on all important variables. Consequently, these variables can be either misrepresented or excluded altogether from the benefit-cost account.

A second key limitation is that some variables which are important to decision makers such as employment and income distribution cannot be properly incorporated into a benefit-cost framework because they are inconsistent with benefit-cost methodology. Employment generation, for example, is not generally counted in benefit-cost analysis because it is assumed that most of the labour employed in a project would be employed elsewhere in the economy if the project did not go ahead. If there are unemployed resources in the economy, provision can be made for including indirectly some of the employment creation benefit by using a shadow price for labour which increases the overall net benefits of the project. Even if a shadow price benefit is included the actual job creation impacts are not explicitly included. Consequently, the decision maker interested in the employment impacts of a project on a small region will not find benefit-cost analysis helpful.

A related issue is the treatment of income distribution; i.e. who gains and who loses from a project. some analysts such as Little and Mirrlees (1974) and Squire and V.D.. Tak (1975) advocate identifying the distribution of benefits and costs by social group and then weighting the impacts depending on the priority of the recipient. A dollar benefit received by a poor person, for example, would be given more weight than a dollar received by a rich person. This is in practice, however, extremely difficult to do. Further, there is some question concerning its theoretical validity in a benefit-cost framework.

The conclusion is that significant factors such as income distribution and employment creation cannot be dealt with adequately within the traditional benefit-cost framework. This is why other accounts are proposed in the multiple accounts analysis to explicitly incorporate these.

3.2 Environmental Quality Account (EQ)

The second account proposed in the P&G is the EQ account. This account is reserved for only those environmental impacts which cannot be monetized. Other environmental impacts which can be monetized are incorporated in the benefit-cost analysis in the NED account. The principal environmental factors included in the EQ account are ecological, cultural and aesthetic attributes. Ecological attributes include functional aspects of the environment (e.g., assimilative capacity, erosion, nutrient cycling, succession) and structural aspects such as plant and animal species, chemical and physical properties of air, water and soil (e.g. pH of rainfall), and so on. Cultural attributes are evidence of past and present habitation that can help in understanding and propagating human life. Aesthetic attributes include sights, scents, sounds, tastes, and impressions of the environment.

It is clear that these attributes would be difficult to measure in monetary terms, although they can be measured in other ways. These include both quantity indicators that employ numeric scales and quality indicators that use non-numeric scales, such as "good" and "bad". It is obvious, however, that the EQ attributes need to be presented in a clear and concise fashion if they are to be of use in the decision making framework.

Several principles govern the planning process with respect to the EQ account. Both an interdisciplinary approach and public involvement are required in the planning process, although the means for involving the public is left at the discretion of the government agency. Further, as in the case of NED costs and benefits, the EQ attributes need to be displayed in a way that highlights the comparison between the "with project" and "without project" scenarios.

Finally, the EQ account is presented in the WRC's P&G to assist agencies in meeting the requirements of the 1969 U.S. National Environmental Policy Act (NEPA) and the NEPA guidelines established by the Council on Environmental Quality. As such, the procedures established by the WRC are meant to facilitate water resources planning to satisfy the aforementioned requirements and environmental requirements under the Endangered Species Act (1973), the National Historic Preservation Act (1966), the Fish and Wildlife Coordination Act (1972), and the Coastal Zone Management Act (1972), and their subsequent amendments. Therefore, straightforward application of the procedures in the EQ account might not be possible. However, the ideas contained therein may prove useful to the establishment of environmental quality procedures for use in evaluating B.C.'s forest and land resources.

3.3 Regional Economic Development Account (RED)

Regional economic development benefits are recognized as an important component of project evaluation in both Canada and the United States. The reasons for this include: (i) a desire to permit people to remain in regions where they grew up or are currently located; (ii) the economic efficiency associated with reduced migration resulting from unbalanced regional economic growth and/or asymmetric growth cycles; (iii) a desire to attract growth away from the more populous regions, thereby reducing the pressures on these regions, and (iv) protecting historical property rights.

The RED account addresses these concerns by utilizing two measures of the effects of the plan on the regional economy: regional income and regional employment. Regional income is measured in dollars and regional employment in person years of employment.

As discussed above, these variables are included in a separate account distinct from the NED benefit-cost account because income and employment measures are conceptually different from costs and benefits. In a fully employed economy, income and employment generated by a project simply utilize resources which would have been otherwise employed. Consequently, there is no incremental gain in income or employment for the economy as a whole. There may be a gain for a particular region in which the project is situated. Consequently, it is useful to measure this potential gain for decision makers concerned with regional impacts.

3.4 Other Social Effects Account (OSE)

The OSE account includes any items that are not included in the other three accounts but are important for planning. While the U.S. WRC's P&G provides no procedures for evaluating other social effects, it does indicate that such effects include urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation. They also include effects on income distribution, employment, population distribution, the fiscal condition of state and local governments, quality of community life, and so on. While some of these effects can be measured in monetary terms and included in the NED account, others need to be displayed using guidelines similar to those of the EQ account.

It appears that public agencies have substantial freedom within the planning process to include whatever items they wish in the OSE account and to display them in any way desired. However, the principles that appear to constrain this freedom are the need for an interdisciplinary approach and displays that highlight the comparison between "with project" and "without project" effects.

3.5 Integrating the analysis

Once the separate account have been constructed, the relevant information is then displayed in a single table indicating impacts on relevant variables with and without the project. The decision makers then compare the plan options and choose the one that maximizes NED subject to environmental, social and regional development constraints summarized in the other accounts.

4.0 Multiple Account Analysis in Canada

Multiple accounts has been used by agencies in Canada charged with the stewardship of natural resources. The Canadian Department of Fisheries and Oceans (DFO), for example, at one time used a five account analysis framework in the Salmonid Enhancement Program (SEP) based upon the Special Task Force Report to the US Water Resources Commission (Canada 1985 p.1) In fact, the economic analysis of the SEP program is based upon the Planning Branch of the Federal Treasury Board report entitled Benefit-Cost Analysis Guide (1976) in which a framework is suggested that incorporates the explicit display of benefits and costs in terms of an account system.

It was thought that because fisheries development projects result in impacts other than those easily measured in monetary terms, a methodology for the evaluation of all the effects of short and long range salmon enhancement proposals was necessary (Canada 1985 p. 1). Consequently, the five accounts (National Income, Regional Development, Native People, Employment and Environmental Preservation) were developed to facilitate the explicit trade-off of alternative goals. Currently, a two account system comprising accounts for economic efficiency and distributional impact is in use. Willingness-to-pay figures are used for non-market goods if possible and, if not, other appropriate quantitative or nonquantitative units are used (Canada 1988 pp. 34-44).

Similarly, recognizing that power generation projects have impacts beyond those that can be measured in monetary terms, B.C. Hydro in 1976 used an account system to forecast and describe the monetary, aesthetic, distributional, and environmental impacts of the Revelstoke Project in the Revelstoke benefit/cost analysis (Reid 1976 p. 15-110).

5.0 Case Study

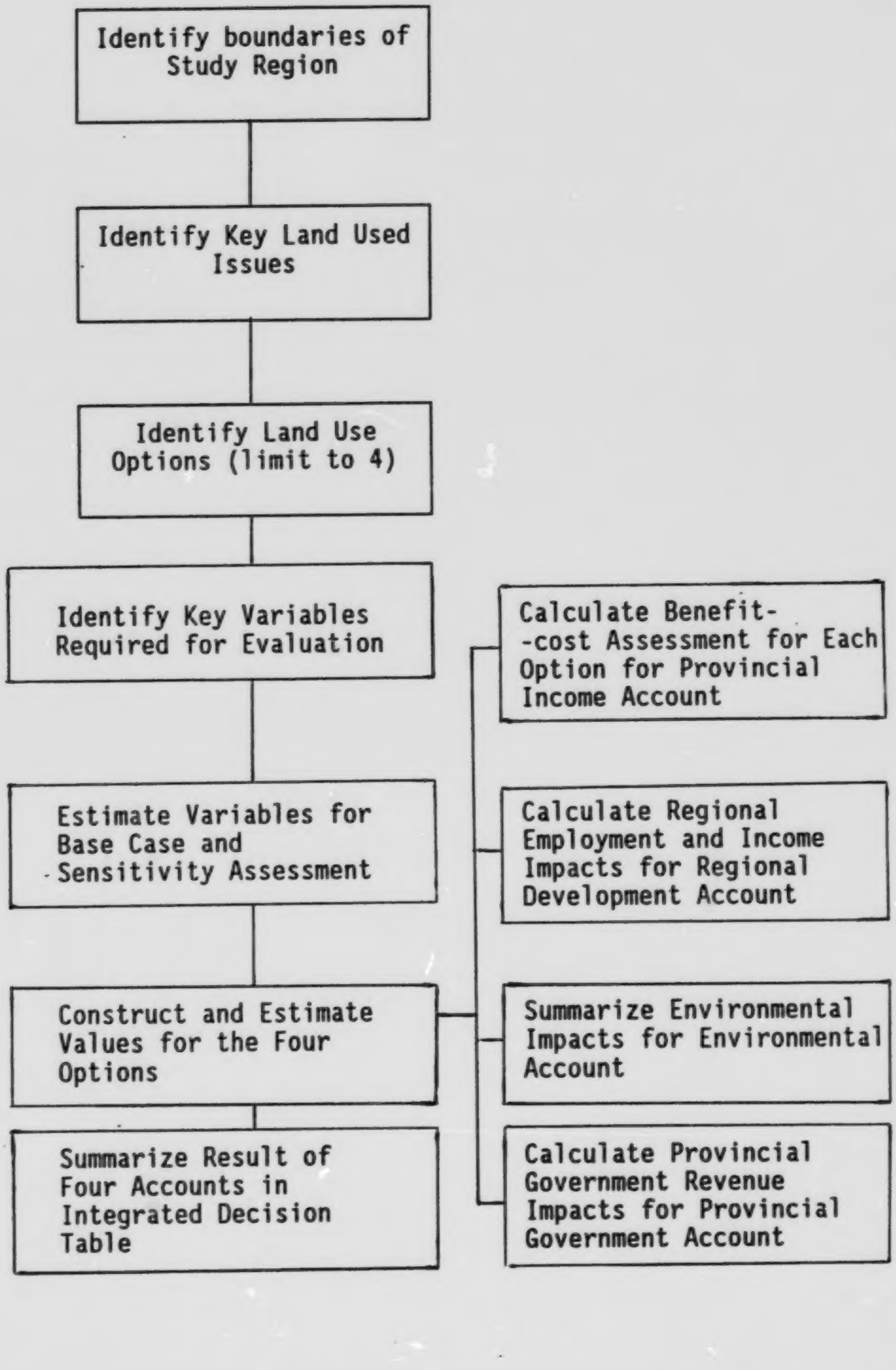
As the previous discussion indicates, multiple account is a flexible technique that has been utilized in a variety of planning processes. It would now be useful to illustrate its applicability to land use conflicts in British Columbia by developing a case study. The case study is based on a study undertaken by the B.C. Ministry of Lands, Parks and Housing (1979). The case study utilizes four accounts; provincial income account, similar to the U.S. Water Resources NED account, a regional development account similar to the U.S. Water Resources RED account, an environmental impact account similar to the U.S. Water Resources EQ account and a government revenue account. The steps in the process are summarized in figure 1. Those wishing more detailed discussion of the assumptions used to estimate impacts should consult the B.C. Ministry of Lands, Parks and Housing report (1979).

5.1 Study Description

The study area is a small region in northern British Columbia of 127 square miles. The area is crown land most of which is forested. The study area is currently utilized for recreation. Potential management options are as follows:

Option 1:	wilderness preservation in which area is preserved for wilderness with no resource extraction
Option 2:	forestry in which area is managed by Ministry of Forests on a sustained yield basis
Option 3:	forestry/agriculture in which part of the area is managed by Ministry of Forests on a sustained yield basis and part sold to farmers for agricultural use
Option 4:	agriculture, in which the entire area is sold to farmers for agricultural use.

Figure 1


Identify boundaries of Study Region
Identify Key Land Used Issues
Identify Land Use Options (limit to 4)
Identify Key Variables Required for Evaluation
Estimate Variables for Base Case and Sensitivity Assessment
Construct and Estimate Values for the Four Options
Summarize Result of Four Accounts in Integrated Decision Table
Calculate Benefit--cost Assessment for Each Option for Provincial Income Account
Calculate Regional Employment and Income Impacts for Regional Development Account
Summarize Environmental Impacts for Environmental Account
Calculate Provincial Government Revenue Impacts for Provincial Government Account

5.2 Provincial Income Account

The provincial income account is based on a benefit-cost analysis utilizing the province's benefit-cost guidelines (Loose, 1977) to estimate the net change in provincial social welfare for each option. The results of this account are presented as net present values summarized below. The results include a base case that represents the most likely value and a range of possible values based on a sensitivity analysis employing different assumptions regarding commodity prices, yields and discount rates.

Table 1

Provincial Income Account

(net present value in millions of constant dollars)

	Range	Base Case
Option 1 (wilderness)	$ 3.2 to 7.1	$ 3.2
Option 2 (forestry)	4.9 to 25.4	14.0
Option 3 (forestry/agriculture)	6.3 to 32.1	19.9
Option 4 (agriculture)	14.5 to 60.3	46.1

5.3 Regional Development Account

The regional development account measures the impact of the four options on regional income and employment. The estimates include only the direct impacts and exclude secondary or multiplier impacts.

Table 2

Regional Development Account

	Direct Employment to Region (# per year)	Proportion of Direct Employment accruing to region (%)	Direct Income to region (millions of $ per yr)	Proportion of total income accruing to region (%)
Option 1: wilderness	0	--	0	--
Option 2: forestry	44	100	2.2	86
Option 3: forestry/agriculture	60	93	2.6	82
Option 4: agriculture	116	69	4.1	61

5.4 Environmental Account

The environmental account summarizes the impact of the four options on various environmental indicators in non-numerical terms. The measure is based on a scale from 1-3 with 3 being the best rating for the environmental factor.

Table 3

Environmental Account

Environmental measure	Option 1 Wilderness	Option 2 Forestry	Option 3 Forestry/ Agriculture	Option 4 Agriculture
Game population	3	3	2	1
Winter habitat	3	2	2	1
Active user aesthetics	3	2	2	1
Casual observer aesthetics	3	3	2	1
Fish diversity and numbers	3	3	3	2
Game diversity	3	3	2	2
Fish habitat	3	3	3	2
Water quality	3	3	2	2
Air quality	3	3	2	2
Total score	27	25	20	14

5.5 Government Revenue and Expenditure Account

The government revenue and expenditure account estimates the impact of the land use options on net government revenue. The structure of this account is conceptually more difficult than the other accounts because it is difficult to estimate net provincial revenue impacts.

Net provincial revenue estimates should incorporate the concept of opportunity cost. If the resources are not employed in the proposed project, they will be employed elsewhere in the economy, thereby generating government revenue. For the economy as a whole, the net gain in revenue is only that above what is generated in the alternative "normal" project. For a small provincial economy, some proportion of the resources employed in the project may be utilized in other projects outside the province. This revenue decline, however, is offset by a decline in expenditures resulting from the decline in provincial demand for services. In practice it is very difficult to estimate these impacts.

Table 4

Government Revenue and Expenditure Account

(Net present value in millions of $)

	Option 1 Wilderness	Option 2 Forestry	Option 3 Forestry/ Agriculture	Option 4 Agriculture
Corporate Income Taxes	Nil	1.3	2.3	5.7
Personal Income Taxes	Nil	.5	.7	1.9
Resource and Land Taxes	Nil	6.9	6.2	3.9
Revenue from Lease or Sale of Land	Nil	Nil	2.5	11.3
Expenditures	Minimal	Minimal	(1.8)	(8.0)
Net Revenue Impact	Nil	10.7	10.6	13.8

Consequently, the net revenue impacts should be interpreted cautiously. A summary of net revenue impacts estimated for the four options appears in Table 4.

5.6 Integrated Analysis

The results of the four account analysis can now be summarized in the following table for decision makers. Decision makers can now assess the relative advantages and disadvantages in an explicit and comprehensive manner. The results indicate that the key tradeoff is between intangible environmental values which are maximized in the wilderness option and economic development and efficiency values which are maximized in the agricultural option. given that difference in provincial income at $42.9 million likely exceeds any reasonable estimate of intangible environmental values, and that the region has no unique environmental qualities, it is likely that the agricultural option is preferred.

Table 5

Integrated Analysis

	Option 1 Wilderness	Option 2 Forestry	Option 3 Forestry/ Agriculture	Option 4 Agriculture
Provincial Income (net present value in millions of $)	3.2	14.0	19.9	46.1
Regional Development				
a) direct permanent jobs in region	0	44	60	116
b) direct income in region ($ per year)	0	2.2	2.6	4.1
Net Provincial Government Revenue (net present value in millions of $)	0	10.7	10.6	13.8
Environmental Impact Score (from 9 to 27 points)	27	25	20	15

6.0 Evaluation

MAA was developed to meet the demand by decision makers for a more comprehensive and explicit treatment of project impacts. Its development can be attributed to the following four factors:

1) the impossibility of including intangible and incommensurable effects in the conventional cost-benefit methodology;
2) the conflict nature of modern planning problems, so that instead of a single decision-maker, various formal and informal decision agencies determine a final choice;
3) the shift from conventional "one-shot" decision-making to institutional and procedural decision-making where many political aspects play a major role; and,
4) the desire in modern public decision analysis not to be confronted with a single and forced solution but with a spectrum of feasible solutions.

The review of MAA in this study indicates that it is a flexible and comprehensive evaluation technique well suited to assessing land use conflicts in British Columbia. Its principal advantages are:

(1) it explicitly incorporates intangibles;
(2) it is comprehensive in that it includes all project impacts relevant to decision makers;
(3) it is flexible;
(4) it displays impacts in a disaggregated fashion as opposed to concealing them in one summary index;
(5) it identifies local as well as provincial impacts and
(6) it provides a consistent framework for assessing relevant options.

The principal limitations of MAA are that it is expensive and time consuming. These problems can in part be overcome by utilizing advanced analytical tools such as an integrated geographical information system, growth and yield models and input-output models which can estimate relevant impacts of land use options quickly and inexpensively. British Columbia currently has much of the necessary data to develop an integrated decision making model suitable for multiple accounts assessment.

A second alleged limitation of MAA is it does not provide a summary measure assessing the overall desirability of each option. Decision makers are instead faced with a list of impacts which are not comparable. Benefit-cost analysis, it is alleged, is superior because it generates a single comparable measure of the social worth of each option. This criticism of MAA is unwarranted in that it ignores the fact that there is no single index which can incorporate all the relevant concerns of decision makers. Indeed, the virtue of MAA is that it allows decision makers to understand the full impacts of each option and place their own weight on the various impacts. Those decision makers interested primarily in economic efficiency, for example, can utilize the economic efficiency account while placing little to no weight on the other accounts. MAA, then, places the final decision regarding resource conflicts in the political arena where it belongs as opposed to concealing values in the guise of some grand index allegedly based on objective, technical analysis.

7.0 Conclusion

The notion of multiple accounts established by the U.S. Water Resources council in 1983 is one that merits consideration and application to the planning of British Columbia's forest and land resources. It recognizes the non-commensurability of effects that result from resource development (or non-development) plans. It also recognizes that planning and decision making are separate processes, and that it is inappropriate to place the burden of decision making upon planners. This is what happens when planners are required to rank plans or justify a project to satisfy a political objective using a cost-benefit criterion (internal rates of return, benefit-cost ratio, net present value). In these circumstances, the tradeoffs among effects are not clearly identified and the decision making process itself may lead to choices that are undesirable because conflict resolution does not occur.

It is the recommendation of this report that cost-benefit analysis be the main tool for evaluating forest and land resource plans, but that provision be made to include so-called intangibles in the planning process. These non-monetary effects are important to B.C. residents. Yet, it is necessary to document them in a way that does not distort the decision making process. The concept of multiple accounts is worth adopting. This requires the establishment of procedures for incorporating the effects in a way that is consistent, concise and facilitates comparison between "with project" and "without project" impacts. It is therefore recommended that B.C. develop a comprehensive system of multiple accounts to be used in the evaluation of land use planning. Procedures for displaying the accounts can be adapted from the WRC's P&G, but must be modified to B.C.'s circumstances and needs.

References

Antle, L.G. 1982. "Multi-objective and Water Resources Decision Making: Trends and Opportunities." In Y.Y. Haimes and D.J. Allee (eds.). Multi-objective Analysis in Water Resources. New York: American Society of Civil Engineers. pp. 75-77.

British Columbia. Ministry of Lands, Parks and Housing. 1979. A Cost/Benefit Methodology to Assist with Land Management Planning Phases I and II. mimeo.

Canada. Department of Fisheries and Oceans. Program Evaluation Branch. 1988. Evaluation Framework of the Pacific Salmonid Enhancement Program (SEP). Final Discussion Draft. mimeo.

Canada. Department of Fisheries and Oceans. Program Evaluation Branch. 1985. The Economic Rationale for Salmonid Enhancement. mimeo.

Castle, Emery N., Maurice M. Kelso, Joe B. Stevens, Lee R. Martin and Herbert H. Stoevener, 1981. "Natural Resource Economics, 1946-75." In (ed.), A Survey of Agricultural Economics Literature, Volume 3: Economics of Welfare, Rural Development and Natural Resources in Agriculture 1940s to 1970s. Minneapolis: University of Minnesota Press, pp. 393-500.

Deason, J.P. 1982. "Water Resources Planning in the New Principles and Guidelines." In Y.Y. Haimes and D. J. Allee (eds.). Multi-objective Analysis in Water Resources. New York: American Society of Civil Engineers, pp. 37-45.

Dreze, J. and N. Stern, 1987. "the Theory of cost-Benefit Analysis." Chapter 14 in Handbook of Public Economics edited by A.J. Auerbach and M. Feldstein. Amsterdam: North Holland.

Grigg, Neil S. 1985. Water Resources Planning. Montreal: McGraw-Hill.

Hall, Warren A. 1982. "Trade-offs in Water Resources Planning and Management." In Y.Y. Haimes and D.J. Allee (eds.). Multi-objective Analysis in Water Resources. New York: American Society of Civil Engineers, pp. 1-12.

Hamilton, Joel R. and Richard L. Gardner, 1986. "Value Added and Secondary Benefits in Regional Project Evaluation: Irrigation Development in the Snake River Basiin," Annals of Regional Science 20 (March): 1-11.

Harberger, Arnold C. 1971, "Three Basic Postulates for Applied Welfare Economics," Journal of Economic Literature 9 (September): 785-797.

Harberger, Arnold C. 1972. Project Evaluation, Collected Papers. Chicago: University of Chicago Press.

Harberger, Arnold C. 1978. "On the Use of Disbritutional Weights in Social Cost Benefit Analysis," Journal of Political Economy86 (April pt.2):S87-S120.

Just, Richard W., Darrell Hueth and Andrew Schmitz, 1982. Applied Economics and Public Policy. Englewood Cliffs, N.J.: Prentice-Hall.

Little, I.M.D. and J.A. Mirrlees, 1974. Project Appraisal and Planning for Developing Countries. Bungay, U.K.: Richard Clay.

Maass, Arther. 1966. "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," Quarterly Journal of Economics 80 (May): 208-26.

Major, David C. 1977. Multi Objective Water Resource Planning. American Geophysical Union: Water Resources Monograph 4. Washington, D.C.

Mishan, E.J. 1982. "The New Controversy about the Rationale of Economic Evaluation," Journal of Economic Issues 16 (March): 29-47.

O'Brian, W.T. 1977. "Multi-Objective Planning Management for Water Resources--Review of Recent Developments in the USA." Australian Water Resources Council Technical Paper No. 29. Canberra, Australian Government Publishing Service.

Obermiller, Fredrick W. 1983. "Opportunities for the More Intensive Use of Input-Putput analysis in Public Rangeland Decision Making." In: Proceedings--Range Economics and Symposium Workshop compiled by Fred J. Wagstaff. U.S. Forest Service Gen. Tech. Rep. INT-149. Ogden: Intermountain Forest and Range Experiment Station. pp. 100-109.

Obermiller, Fredrick W. 1982. "Economic Efficiency vs. Distributive Equity: the 'Sagebrush Rebellion'", Western Journal of Agricultural Economics 7(1982):253-63.

Prest, A.R. and R. Turvey, 1974. "Cost-Benefit Analysis: A Survey". In Readings in Natural Resource Economics, eds. John E. Reynolds, J. Margin Redfern, and Robert N. Shulstad. New York: MSS Information Corporation, pp. 145-71.

Reid, David J. 1976. Revelstoke Benefit-Cost Analysis. Vols. I and II. B.C. Hydro and Power Authority. mimeo.

Smith, B. Kerry. 1986. "A Conceptual Overview of the Foundations of Benefit-Cost Analysis." Chapter 2 in Benefits Assessment: The State of the Art edited by Judith D. Bertkover, Vincent T. Covello and Jerly Munmpower. Dordrecht: D. REidel Publishing Co.

Squire, Lyn and Herman G. Van Der Tak. 1975. Economic Analysis of Projects Baltimore: John Hopkins University Press (A World Bank Research Publication).

Stabler, Jack C., G.C. Van Kooten and Neil Meyer. "Methodological Issues in Appraisal of Regional Resource Development Projects," The Annals of Regional Science 22 (July 1988): 13-25.

U.S. Water Resources Council. 1973. "Water and Related Land Resources: Establishment of Principles and Standards for Planning," Federal Register 38 (174 December 10):34778-869.

U.S. Water Resources Council. 1979. "Principles and Standards for Water Planning Water and Related Land Resources," Federal Register 44(242): 72878-976.

U.S. Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Washington, D.C.: Mimeograph, March 10.

Weber, Jeff, Norman Whittlesey and Eric Elder. 1986. "State-Level Water Project Evaluation: The Role of Input-Output Analysis." Paper presented at the Annual Meeting of the American Agricultural Ecomomics Association in Reno, Nevada.

Young, Robert A. and Robert H. Haveman. 1985. "Economics of Water Resources: A Survey." Chapter 11 in Handbook of Natural Resource and Energy Economics (Vol. II), edited by Allan V. Kneese and James L. Sweeney. Amsterdam: North-Holland.

Young, Robert A. and S. Lee Gray. 1985. "Input-Output Models, Economic Surplus, and the Evaluation of State or Regional Water Plans," Water Resources Research 21 (December): 1819-1823.

ECONOMIC VALUATION OF NON-MARKET VALUES FORFOREST LAND PLANNING

Background Study

Prepared for

THE FOREST RESOURCES COMMISSION

Dr. Thomas Gunton, Director
Natural Resources Management Program
Simon Fraser University
Burnaby, B.C.

February, 1991

NON-MARKET VALUATION

A principal task in land use planning is evaluating the costs and benefits of allocating land between alternative uses. Other background studies review selected techniques. The purpose of this background study is to evaluate methods for estimating the economic values of goods and services for which there are no observable market prices. The report begins with a discussion of economic value, followed by a review of alternative techniques for evaluating non-market goods and services. Several case studies are included to illustrate the application of benefit-cost analysis in assessing non-market values.

1.0 LAND RESOURCE BENEFITS

Land resources provide a diversity of services ranging from growing harvestable crops such as timber to providing wilderness hiking. Analysts have identified several types of value in their attempt to assess the total benefit of alternative land use policies. Although there are different classification systems, value can be conceptually divided into the following categories.

1.1 Use Value

Use value is the value derived from the present or anticipated direct physical use of the resource. Direct uses include activities such as growing timber, fishing and hunting, scenic wilderness hiking, and generation of knowledge through scientific study. Use value normally forms the basis of benefit estimates because it is more amenable to economic measurement.

1.2 Existence Value

Existence value is the value derived by people knowing that something exists even if they have no interest in physically using it (Krutilla and Fisher, 1975). People may be willing to contribute to an environmental fund, for example, to preserve endangered species even if they have no interest in ever viewing the species.

Existence value can be subdivided into vicarious consumption by which value is generated by the knowledge that others are benefitting from the resource and stewardship by which value is generated by knowing that a resource is being managed in a responsible manner. Bequest value, a subcategory of existence value, is derived from knowing that a resource will be passed on to future generations.

1.3 Option Value

Option value, first identified by Weisbrod (1964), is the value derived from reducing risk. In the case of land use decisions, society derives a benefit from a decision which leaves future options open. Irreversible land use decisions such as logging a unique wilderness area, for example, will be discounted relative to decisions such as preservation which leave future options open.

A related concept is quasi-option value which reflects people's willingness to pay to defer decisions which foreclose options in the anticipation that society will be able to make a more informed decision at a later date. It may be prudent, for example, to postpone harvesting timber which requires high infrastructure cost until future timber prices are less uncertain. The difference between quasi-option and option value is that option value may include a permanent prohibition of land use.

1.4 Relative Significance of Benefit Categories

Option and existence values are normally excluded from benefit estimates because they are more difficult to measure than use values. Recently, however, attempts have been made to estimate option and existence values to ascertain their relative significance. Walsh and Loomis (1989) estimate that option and existence values for wilderness preservation are approximately equal to use values. Similar results were obtained in studies by Pope and Jones (1987) and Prince (1988). While the estimate of option and existence values is difficult due to the inability of consumers to distinguish between the various components of value, the research shows that the exclusion of these can result in a significant underestimate of benefits.

2.0 CONTINGENT VALUATION METHOD (CVM)

2.1 Introduction

One of the most popular techniques for estimating non-market values is the contingent valuation method (CVM). CVM attempts to simulate market behaviour by asking consumers through a social survey what they would be willing to pay for a good or service. The value of the good is estimated by multiplying the average willingness to pay by the number of consumers.

The method was first used by Davis (1963) to estimate the benefits of outdoor recreation in the United States. Since Davis's pioneering work, CVM has been utilized to measure a diversity of public goods including recreation (Walsh, Miller and Gilliam, 1983), hunting (Sorg and Nelson, 1986), fishing (Sorg, et al., 1985), wilderness preservation (Walsh, Loomis and Gillman, 1984), and environmental quality (Jackson, 1983).

The extensive research on CVM has resulted in its widespread acceptance and credibility as a method for estimating non-market values. Research by Randall et al. (1974), Hoehn and Randall (1987) and Cummings et al. (1986) supports the theoretical basis of CVM. Various manuals and guidelines employed by government agencies recommend the use of CVM in project evaluation. Commencing in 1979, for example, the

US Water Resources Council (1983) included CVM as an appropriate technique for estimating project costs and benefits. The US Army Corps of Engineers now uses CVM in a number of its project evaluations and has recently published a handbook on CVM (Moser and Dunning, 1986). CVM is also accepted as an appropriate method for measuring benefits and damages under the comprehensive Environmental Response, Compensation and Liabilities Act (1980) and in civil litigation. In British Columbia, CVM is a recommended technique in the province's Guidelines for Benefit Cost Analysis (1977) and has been utilized in numerous project evaluations, largely in hydro development.

2.2 CVM Techniques

Although the concept underlying CVM is relatively simple, a number of different survey approaches have been developed to elicit consumer responses. The simplest technique is an open ended question asking people what they are willing to pay for the public good. This approach has been criticized because respondents often do not have sufficient information or experience to accurately estimate the value. Further, this approach does not simulate market behaviour very well. In normal markets, people are presented with a good for sale at a specific price; not a question of what they are willing to pay.

Another technique is the dichotomous choice method in which consumers are asked whether they would pay a specific price or not. Advocates of this approach argue that it better simulates real market transactions in which people either purchase or don't purchase goods at the stated selling price (Bishop et al., 1986; Bowker and Stoll, 1988). This approach is more expensive because it requires a larger number of observations to achieve the same level of statistical reliability as the other techniques (Mitchell and Carson, 1989).

A third technique developed by Randall et al. (1974) is an iterative bidding process in which the consumer is asked whether they would pay a specific price for the good in question. If the answer is affirmative, the interviewer raises the amount by successive increments until the response is no. The amount is then lowered by smaller increments until agreement is reached. Advocates of iterative bidding maintain that it is easy for respondents to understand, given that it is based on a common auction process. Also, the iterative process gives respondents the opportunity to better contemplate their answers (Hoehn and Randall, 1987; Cummings, Brookshire and Schulze, 1986). The principal problem with this approach is that the starting point of the bidding can influence the respondents answer (Roberts, Thompson and Pawlyk, 1985).

A more recent approach advocated by Mitchell and Carson (1989) is the payment card which provides respondents with a range of values on a single card. Often some specific price data and included such as the cost of providing various public goods. The respondents are then asked to choose the value which best represents their willingness to pay. The alleged advantage of this approach is that it has the same advantages of iterative bidding, while overcoming the problem of the starting point bias. The method can still bias the result by the range of values provided on the card.

2.3 Advantages of CVM

Advocates of CVM cite a number of advantages. First, CVM is consistent with the theory of individual choice and welfare measurement (Smith, 1987). Second, CVM is flexible. The technique can be modified to incorporate changes in quality, quantity, alternative payment mechanisms, market structures and types of tradeoffs related to most non-market situations. This flexibility is reflected in the wide application of CVM to different types of valuation problems ranging from expenditures on reducing risk to wilderness preservation. Third, CVM can incorporate non-user values such as option and existence values into the valuation. As discussed earlier in this report, these values are significant. Finally, CVM is relatively inexpensive.

2.4 Issues and Problems

2.4.1 Hypothetical Bias

CVM requires respondents to speculate on their behaviour in hypothetical market situations. A potential problem is that because respondents don't actually make a purchase, they lack the same incentive that they have in a normal market situation to undertake the research and contemplation required to give accurate responses (Freeman, 1979b). Some researchers suggest that this problem can be minimized by ensuring that the question be based on a believable scenario fully understood by the respondent. It should also be emphasized to the respondent that his answer will be an important factor in the decision (Hoehn and Randall, 1987). If respondents are convinced that their answer is significant, they will be more likely to seriously assess their willingness to pay.

2.4.2 Strategic Bias

If respondents think that their valuation can influence the result, they may overbid or underbid depending on their preferences. In forestry-wilderness tradeoffs, for example, those in the forest industry have an incentive to understate their valuation of wilderness while wilderness preservationists may exaggerate their value. If respondents think that they may be required to pay their valuation, they may have an incentive to understate. Attempts to reduce hypothetical bias by emphasizing the significance of the respondent's answer in the decision making process may therefore increase strategic bias.

A number of studies testing for strategic bias show, however, that it is not a significant problem (Rowe, d'Arge and Brookshire, 1980; Brookshire, Ives and Schulze, 1976; Bohm, 1984). Further, the potential strategic bias can be reduced by eliminating extreme responses (Randall, Hoehn and Brookshire, 1983).

2.4.3 Instrument Bias

Research shows that the valuation of a non-market commodity may be affected by the method of payment specified in the survey (Greenly, Walsh and Young, 1985; Brookshire et al., 1981). Respondents, for example, may be willing to pay more for a good if the payment is made by an entrance fee instead of by a general tax increase. Based on their extensive review of the evidence, Cummings et al. (1986) conclude that the method of payment is an important factor affecting results. Arrow (1986) and Kahneman (1986) conclude that the search for an "unbiased" payment vehicle is misguided because the means of payment is itself an integral part of the evaluation. Cummings et al. (1986) therefore conclude that the influence of the means of payment on the respondent's valuation is not a problem.

2.4.4 Starting Point and Range Bias

If iterative bidding is used to solicit respondents' valuation, the starting point of the bidding can influence the result. This is especially true when the respondent is unfamiliar with the good and is consequently more likely to be influenced by the survey design. The evidence of starting point bias is mixed, however, with some studies finding no evidence of bias and others finding substantial evidence of bias. After an exhaustive review of the evidence, Cummings et al. (1986:207) conclude that starting point bias is a potential problem.

Mitchell and Carson (1989:241) suggest that there is no satisfactory way for compensating for this problem with iterative bidding. They recommend using payment cards which present the respondent with a range of values. Although the range may influence the results, this is a less significant source of bias (Mitchell and Carson, 1989: 242).

2.4.5 Willingness to Pay Versus Compensation Demanded

Economic theory suggests that the amount that consumers are willing to pay (WTP) for a marginal increase in consumption should be about the same as the amount they are willing to accept (WTA) as compensation for an equivalent decline in consumption. The research summarized in table 1 shows that WTA amounts exceed WTP by a wide margin. To date there is no satisfactory explanation for the divergence in WTP and WTA.

Table 1

Measures of WTP and WTA

Study	WTP	WTA	WTA/WTP
Hammack and Brown (1974)	$247.00	$1044.00	4.2
Banford, Knetsch, and Mauser (1979/80)	43.00	120.00	2.8
	22.00	93.00	4.2
Sinclair (1976)	35.00	100.00	2.8
Bishop and Heberlein (1979)	21.00	101.00	4.8
Brookshire, Randall, and Stoll (1980)	43.64	68.52	1.6
	54.07	142.60	2.6
	32.00	207.07	6.5
Rowe, d'Arge, and Brookshire (1980)	4.75	24.47	5.2
	6.54	71.44	10.9
	3.53	46.63	13.2
	6.85	114.68	16.6
Coursey, Hovis, and Schulze (1987)	2.50	10.50	3.8
	2.75	4.50	1.6
Knetsch and Sinden (1984)	1.28	5.18	4.0
Haberlein and Bishop (1986)	31.00	513.00	16.5

[a] All amounts are in year-of-study dollars.

Source: Fisher, McLelland & Schulze (1988), 129.

Should WTP or WTA be used in benefit estimates? Knetsch, one of the leading researchers in this area, suggests that WTP should be used when considering supplying more of something and WTA when withdrawing supply (Knetsch, 1984). Cummings et al. (1986:218) prefer WTP because WTA values are less stable and tend to converge towards WTP values during successive rounds of valuation. They caution, however, that WTA should not be rejected out of hand (Cummings et al. 1986:221).

2.4.6 Aggregation and Sequencing

It is tempting to estimate the aggregate value of a commodity by summing results of various commodity estimates. For example, the value of wilderness areas could be estimated by adding up individual CVM estimates for each separate wilderness area. The result, however, would be meaningless because consumers view different wilderness areas as potential substitutes. Summing the results would be equivalent, for example, to asking a consumer wishing to purchase a new car what he would be willing to pay for each of three different cars he is shown then adding up the three values to estimate his willingness to pay for a new car. This problem can be avoided by simply not aggregating individual CVM studies.

A related problem which is more problematic is embedding. Tolley and Randall (1983) found that estimates of the value of improved air quality in the Grand Canyon varied by a factor of three depending on whether the question was asked before or after questions dealing with air quality in the residents own city. Kahneman and Knetsch (1990) in a series of CVM valuations also show that the valuation of a commodity is significantly affected by whether the question is asked separately or in conjunction with other related commodities. The results show that respondents were willing to pay similar amounts for a narrowly defined good such as breast cancer research as they are for a more inclusive good such as cancer research. As in the case of WTP versus WTA, it is not clear which is the correct value. Kahneman and Knetsch conclude that there is no satisfactory answer to this question. They further conclude that the reason for these anomalous results is that respondents are actually valuing the non-market commodities in terms of moral satisfaction; not in terms of the value of the commodity per se. They conclude, therefore, that CVM is a fundamentally flawed as a technique for estimating economic values. This is a significant and recent challenge which should be closely monitored.

2.4.7 Forecasting

Most non-market goods generate a flow of services over time. Consequently, estimating the present worth requires forecasting future values and capitalizing them at an appropriate discount rate. Forecasting future prices is difficult at the best of times. In the case of non-market items, forecasting is particularly difficult because CVM estimates are usually not available in a consistent time series amenable to standard forecasting techniques. A related question is how long the results of any particular CVM valuation are relevant.

After reviewing the literature, Mitchell and Carson (1989: 285) conclude that values for public goods have been relatively stable. While these limited studies provide some comfort, lack of consistent time series of non-market values impedes confident forecasting and value estimation.

2.4.8 Reliability

One of the best tests of the reliability of CVM results is to compare the CVM estimates to actual market values. Given that CVM is used to estimate non-market commodities, such comparisons are difficult. Nonetheless, a number of comparative studies have been under taken using various valuation methods. The results are summarized below in Table 2.

Table 2
Comparisons of CVM Results

Study	Commodity	Value[a] Based on CVM	Value[a] Based on Alternative Method	Alternative Method
Knetsch and Davis (1966)	Recreation days	$1.71 per household/day	$1.66 per household/day	TCM
Bishop and Heberlein (1979)	Hunting permits	$21.00 per permit	$11.00	TCM value of time =0
			$28.00	value of time = 1/4 median income
			$45.00	value of time = 1/2 median income
Desvousges, Smith and McGivney (1983)	Water quality improvements: a) loss of use b) Boatable to fishable c) boatable to swimmable	User values:[b] average across question format)[b] $21.41 $12.26 $29.64	User Values: $82.65 $ 7.01 $14.71	TCM
Seller, Stoll and Chavas (1984)	Boat permit to:	Close-ended consumer surplus:		TCM
	Lake Conroe	$39.38	$32.06	
	Lake Liningston	$35.21	$102.09	
	Lake Houston	$13.01	$13.81	
Thayer (1981)	Recreation site	Population value per household per day $2.54:	Population value per household per day: $2.04	Site substitution
Brookshire, et al. (1982)	Air quality improvements:	Monthly value[c]		HPM (property values)
	a)poor to fair	$14.54	$45.92	
	b)fair to good	$20.31	$59.09	
Brookshire, et al. (1985)	Natural hazards (earthquakes) information	$47 per month	$37 per mo.	HPM (property values)
Bishop and Heberlein (1986)	Hunting permits	$32.00	$24	cash bid

[a] Mean values among respondents.
[b] Values apply to post-iteration bids for users of the recreation sites.
[c] Values for sample population.

The results indicate reasonable convergence between CVM results and results using other methods. Given that CVM measures non-user benefit values such as option and existence value while other techniques such as travel cost exclude these values, the degree of convergence is impressive. Also interesting are the results of recent experiments (Bishop, Heberlein, Kealy, 1983; and Heberlein and Bishop, 1986) in which hunters were offered real dollars for hunting permits, creating an actual market to compare to CVM results.

Mitchell and Carson (1989) and Cummings et al. (1986) caution that while such comparisons are encouraging, they are not definitive. Most comparisons are between hypothetical values estimated by alternative techniques. There is therefore no actual benchmark of market values for comparison. Second, the convergence is strong for only those goods which are well defined with which respondents are familiar. The results are not as encouraging for less tangible goods such as clean air. Finally the results still show significant divergence. Based on the evidence, Cummings et al. (1986) conclude that CVM estimates are accurate with plus or minus 50 percent of market values.

2.5 Guidelines for CVM

The foregoing discussion indicates that there are alternative approaches to conducting CVM studies each with advantages and disadvantages. To improve the validity and consistency of results, the U.S. Government has published detailed guidelines for CVM studies. (Water Resources Council, 1983) Subsequent to the publication of these guidelines, Cummings et al. (1986) assessed the validity of alternative approaches in a major conference. Based on their analysis, the authors suggest the following guidelines for CVM studies (Cummings et al., 1986:167).

1) Respondents must be familiar with the commodity being valued.
2) Respondents must have had prior valuation and choice experience with respect to the commodity either through direct market experience or hypothetical market experience.
3) Uncertainty regarding payment mechanisms should be minimized.
4) Willingness to pay should be employed.

Some guidelines proposed for consideration but not formally adopted by the authors are as follows: (Cummings et al. 1986, 231).

1) CVM value should related to use with minimum ideological content.
2) Results should be considered unique to the payment mechanism specified.
3) CVM should exclude starting points or any other information which may influence the respondents valuation.
4) Respondents should be given as simple a choice as possible.
5) Outliers (extreme responses) should be excluded.
6) Subjects should view the response as an important consideration in policy making.

Mitchell and Carson (1989:301-303) also propose "best standard practice" guidelines for evaluating CVM studies.

3.0 TRAVEL COST METHOD (TCM)

3.1 Introduction

A popular alternative to CVM is the travel cost method. The travel cost method has been refined since its initial applications in the pioneering work of Davis (1963) and Clawson and Knetsch (1966). Like CVM, it is now widely accepted in various guidelines and manuals such as the US Water Resources Council Guidelines (1983) and the British Columbia Benefit-Cost Guidelines (1977).

The underlying concept of the TCM is quite simple. Travellers to recreation sites incur measurable travelling costs which can be used to estimate the willingness to pay for the site. The method can be best illustrated by an example based on Clawson and Knetsch (1966).

Step 1: Collect data on the number of visits and the origin of the visits by surveying visitors to the site.

Step 2: Divide visitor origin into zones of increasing travel costs and estimate the travel costs incurred for each zone and the number of visitors originating in each zone.

Step 3: Obtain the population per zone and estimate the number of visits per unit of population.

Hypothetical information from these first three steps is summarized in the following table.

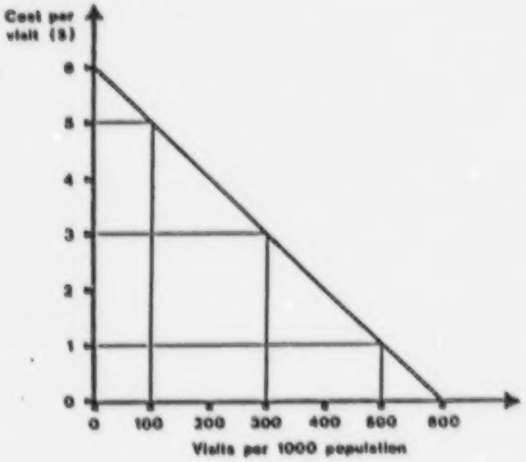
Table 3

Summary of Visitor Data

Zone	Population In Zone	Cost per Visit From Zone	Number of Visits	Visits for per 1000 population
1	1,000	$1	500	500
2	4,000	$2	1,200	300
3	10,000	$5	1,000	100

This data can also be summarized in the following figure showing the relationship between costs per visit and the number of visits per 1000 population.

Figure 1



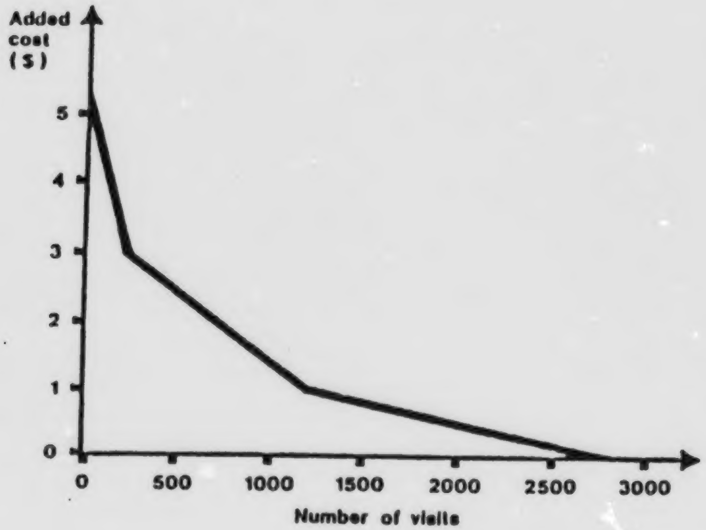
Step 4: Estimate the number of visitors at various prices. At $0 entrance fee (the actual situation) the number of visitors are 2,700 from the three zones. If the entrance fee was $1, the costs incurred by visitors from Zone 1 is now $2, Zone 2 is $4 and Zone 3 is $6. Based on Figure 1, the visitors per 1000 population at $2 is 400, at $4 is 200 and at $6 is 0. The hypothetical number of visitors from each zone if the entrance fee was $1 can now be calculated by multiplying the population per zone by the visits per 1000 population for each zone. This can be done for successive increments, resulting in a total visitor estimate at each price. The results are summarized below.

Table 4
Number of Visits at Alternative Prices

Zone	0	$1	$2	$3	$4	$5
1	500	400	300	200	100	0
2	1200	800	400	0	0	0
3	1000	0	0	0	0	0

Step 5. This information can now be plotted on a demand curve showing the quantity demanded as a function of prices. The value of the site is then given by estimating the area under the demand curve which is the total willingness to pay.

Figure 2



A principal advantage of TCM is that the data on site visits necessary for calculating values is usually readily available. Consequently, the technique is relatively inexpensive to use. Second, TCM uses actual consumer expenditures to estimate non-market values.

3.1 Issues and Problems

3.1.1 Time Cost

As Cesario and Knetsch (1970) conclude, the opportunity cost of time taken to travel to a site should be included along with the out of pocket costs of travel. Failure to include time cost results in an underestimate of site value. Estimating the opportunity cost of time, however, is difficult. Cesario (1976) concludes based on a review of a number of studies that the cost of time is equivalent to between one-quarter and one-half of the wage rate. Freeman (1979b) correctly observes, however, that these estimates used by Cesario are based on travel to work which are not applicable to recreation travel. Indeed, studies by Sutherland (1982) and Walsh, Sanders and Loomis (1985) indicate that travel time can be a benefit improving the overall recreation experience, not a cost. Another problem noted by Bishop and Heberlein (1979) is that the wage rate overestimates the opportunity cost of time because it is unlikely that the time spent travelling to a recreation site would otherwise be spent working at the same job. The issue of appropriate travel time costs continues to be an unresolved problem which can bias estimates.

3.1.2 Multi Destination Trips

Many recreation trips involve travel to more than one site. The problem is how to allocate the costs for each individual component of the trip. Allocation of the full costs to the recreation site would clearly bias the valuation of site benefits upward. One solution developed by Beardsley (1971) is to allocate travel costs in proportion to the amount of time spent at each site relative to the total time spent at all sites. This assumes that the benefits derived per site are equivalent to the amount of time spent. An alternative approach proposed by Haspel and Johnson (1982) is to divide the costs evenly between all destinations, with some adjustment for destinations in close proximity. One possibility is to survey visitors to assess the relative importance of each destination in their overall trip. But if surveys are used, willingness to pay questions might as well be employed.

3.1.3 Substitutes

TCM is usually employed to estimate the value of a single site. The problem is that there are often alternative sites which consumers can utilize (Freeman, 1979b). Consequently, the value of the single site can be over estimated unless alternative sites are taken into account in the valuation by using a multi-site travel cost model (McConnell, 1985).

3.1.4 Flexibility

TCM is limited to measuring only user benefits. Therefore, it can significantly underestimate the value of a site by excluding important non-user benefits such as option value and existence value. Also, it is difficult to utilize TCM to estimate the impact of quality and quantity changes to the site. The costs of congestion, the benefits of facilities improvement, or water quality for example can not be directly measured. Instead, these types of costs and benefits can only be indirectly measured by comparisons of site values as a function of site characteristics. Overall, then, TCM is not as flexible as CVM.

4.0 HEDONIC PRICE METHOD

The price of a good is a function of a bundle of attributes. The value of a recreation site, for example, is a function of a number of factors such as distance, facilities, availability of recreation activities, environmental quality and scenic value. The difference in attributes allows for the valuation of specific features by using statistical methods to assess the impact of each individual characteristic. In effect, a site with good fishing can be compared to other sites which are similar in other respects other than the availability of good fishing. The difference in price can then be used to estimate the value of fishing.

This hedonic price method was initially developed by Griliches (1971) and Rosen (1974) to measure the value of improved quality of consumer goods. It was soon used in property value studies to estimate the impact of environmental characteristics such as air quality, noise and scenic values. Housing in low quality air zones, for example, is compared to similar housing in areas with better air quality to estimate the benefits of improving air quality (Harrison and Rubinfeld, 1978; Freeman, 1981), water quality (Brown and Pullakowski, 1977), and noise. The hedonic price method has also been used in conjunction with the TCM to estimate the costs and benefits of congestion, environmental quality and other site attributes (Binkley and Hanemann, 1978).

The principle advantage of the hedonic price method is that it uses actual market data to estimate non-market values. Unfortunately, it also has serious disadvantages. First, it is difficult to control for all the significant variables which affect price. Sufficient market data is often simply not available (Just, Hueth and Schmitz, 1982). Second, there are different formulations of the underlying price relationships which give different results. The actual relationship is usually unknown (Freeman, 1979c). Third, it assumes perfectly functioning markets. Consumers, however, may have insufficient information on non-market characteristics to accurately assess site attributes. Finally, expectations of future trends are capitalized into existing prices, making it difficult to isolate the effect of any individual characteristic. For these reasons, the hedonic price method has limited applicability.

5.0 INDIFFERENCE CURVE MAPPING

Indifference curves for commodities and their attributes can be estimated by interview techniques which require consumers to choose between competing bundles of goods (Sinden, 1974). Consumers are asked to rank alternative bundles relative to each other. Based on these rankings it is possible to estimate indifference curves which in turn can be used to estimate the demand curve and consumer surplus for the good in question. Although this technique has been available for several decades, it is not widely used in non-market valuation of land use values because it requires lengthy and costly survey efforts which consumers may find more difficult to understand than contingent valuation.

6.0 CASE STUDIES

6.1 Introduction

The foregoing discussion summarizes the theoretical issues related to non-market evaluation. To complement this discussion it would be useful to analyze several case study applications of non-market evaluation to illustrate the practical issues involved. Two case studies have been chosen which are relevant to issues in British Columbia. The first one deals with a single watershed conflict between forestry and non-forestry uses. The second one deals with the issue of allocating the aggregate land base of a region between resource extraction and wilderness preservation.

6.2 A Watershed Conflict

A common land use problem in British Columbia is the conflict between logging and wilderness preservation. One of the many watersheds experiencing this conflict is the Stein River, an area of 329 square miles located near Lytton, British Columbia. It has been the focus of conflict between logging interests and preservationists for almost two decades. The Stein has been chosen as a case study of the use of non-market evaluations because of the availability of data. Two management options are analyzed: a logging option based on a Forest Service proposal and a wilderness recreation option. It should be emphasized that although the case study is based on actual data, the results are intended to illustrate the application of the technique; not to provide definitive results relevant to the Stein. Those wishing more detail on the study should consult Gunton, et al. (1986).

Recreation benefits are estimated as follows. First, an estimate of user days in the Stein value was obtained from survey data. The activities were divided into wilderness hiking, day hiking, hunting and fishing. Second, the value per user day was estimated by using the U.S. Forest Service recommended values for willingness to pay. These values are lower than most values derived in contingent value and travel cost studies, but are nonetheless useful for illustrative purposes. Multiplying the user days by user day values then provides an estimate of the value of recreation benefits in year 0.

The next step is to estimate the value in future years by forecasting. As discussed earlier, this is difficult because there is no available time series data showing past trends. Nonetheless, it is reasonable to assume that user days will increase as a function of population growth. Consequently user days are forecast to increase at the same rate as the increase in B.C. population of about 2.35% per year. Following Krutilla and Fisher (1975) and Knetsch and Fleming (1977), it is also reasonable to expect the value of user days to increase in real terms because recreation is a superior good for which willingness to pay will increase at a faster rate than income and the supply of unique wilderness areas is fixed. Consequently, it is conservatively assumed that willingness to pay will increase at the same rate as per capita income. The formula used to estimate recreation benefits is summarized below.

$$TB = \overset{N}{\underset{T=0}{}} \frac{(UD_0 \text{ X } (1+UI)^t \text{ X } (CD_0 \text{ X } (1+WI)^t)}{(1+R)^t}$$

Where TB = net present value of total recreation benefits from year 0 to 34
N = total number of years for which benefits calculated
T = year for which benefits calculated
UD_0 = number of user-days annually at a time t-1
UI = annual compounded rate of increase in demand for user-days
CD_0 = value of a user-day based on compensation demanded criteria at time $t=0$
WI = annual compounded rate of increase in the value of a user-day
R = social discount rate

Given the uncertainty involved in these assumptions, a sensitivity analysis has been completed utilizing the following alternative assumptions:

1) no growth in total annual recreation benefits (i.e. no growth in user days or user day values),
2) a more rapid growth in user day values based on willingness to pay increasing 2.1 times faster than income, based on the Economic Council's estimate of the income elasticity of recreation expenditures of 2.1 (Gunton et al., 1986:39).
3) using compensation demanded instead of willingness to pay. Compensation demand is estimated by multiplying willingness to pay by 3.25 which is a mid point estimate of the ratio between willingness to pay and compensation demanded estimated in various studies summarized by Knetsch, 1984.
4) three different discount rates of 8%, 10%, and 12% are utilized as recommended in the province's cost-benefit guidelines.
5) inclusion of option and existence values estimated by multiplying the use value estimates in the base case by 2.1 which is the ratio of option and existence values to use values estimated in a recent study by Walsh and Loomis (1989).

Offsetting the benefits are recreation management costs estimated to be equivalent to average forest management costs. The net benefit estimates of the recreation option are summarized in table 5.

The principal benefit of logging the Stein is the value of forest products produced. The proposed logging plan estimates that 125,000 m^3 of timber will be cut each year for 32 years. Logging will commence after 3 years of road construction required to access the timber. Output consists of two products: lumber produced at a local sawmill and wood chips (a by-product of sawmilling) sold to a pulp mill.

Estimating the benefit of these two forest products involves multiplying price times quantity produced per year and discounting the results. Lumber and wood chip prices are taken from a recent study by Gunton et al. (1986). A "best guess" price is used for the base case analysis. Because of the uncertainty over prices, a sensitivity analysis using an optimistic and pessimistic price and a threshold analysis estimating the price required to cover the costs of logging are also completed. A secondary benefit of logging is the construction of a bridge across the Fraser River which will obviate the need to operate an existing ferry. This saving is included as a benefit of the logging option.

The Stein will also provide recreation benefits even if it is logged. These are even more difficult to estimate than recreation benefits generated by the wilderness option because the impact of logging on willingness to pay and user days is unknown. One study, for example, assumes that wilderness recreation benefits will actually increase with logging because of the improved accessibility resulting from the construction of logging roads (Bowden, 1986). In effect, this study implies that there is no tradeoff between logging and wilderness recreation. This assumption is dubious given that the recreation value of the Stein is based on its status an a unique unlogged watershed. If it is logged it becomes similar to a number of more accessible watersheds and its value should consequently decline. Therefore, a more realistic assumption is that recreation benefits of wilderness hiking will be nil under logging while benefits for day hiking, fishing and hunting will remain the same as for wilderness recreation. A sensitivity analysis is also done assuming that recreation benefits will decline by only one-half if the area is logged. Additional analysis on the impact of logging on recreation benefits is required to confirm these assumptions.

The principal costs in logging are the opportunity cost of labour and capital employed logging and processing the timber, building a bridge and roads to access the timber and general costs associated with managing logging operations. These costs were obtained from the B.C. Forest Service and the principal logging company involved (Gunton et al., 1986).

Market prices are not necessarily a valid measure of costs and benefits if there are market imperfections. The market power of pulp mills, for example, may allow them to pay artificially low prices for wood chips. The administrative allocation of timber to specific sawmills can result in costs being higher then socially necessary if the specified sawmill is inefficient. Labour costs can be higher than their social opportunity cost because of the bargaining power of the forestry workers union. Adjusting for these market imperfections is in practice formidable. Given the uncertainty in shadow pricing, the adjusted value may not be any closer to the real social value. For example, higher wages in the forestry sector could be due to a number of factors such as increased risks, not the power of forestry unions. Market prices, therefore, are used in the base case analysis. A sensitivity analysis using a shadow price for labour estimated as the average manufacturing wage is included, however.

Table 5 summarizes the results of the economic evaluation. The results indicate that there is a wide range of values for each option. Recreation benefits vary between $1.0 million and $6.9 million depending on the assumptions employed. The results are most sensitive to the choice between willingness to pay and compensation demanded, forecasts of future recreation values and the inclusion or exclusion of option and existence values. Economic value of the logging option vary between $1.8 million in benefits to $11.5 million in costs. This option is most sensitive to future lumber price assumptions. Interestingly, the range of values for the logging option is greater than for recreation. This suggests that the uncertainty in measuring so called tangibles such as logging can be greater than for intangibles such as wilderness recreation.

Table 5
Net Present Value of Management Options
For Stein Watershed
(millions of 1984 $)

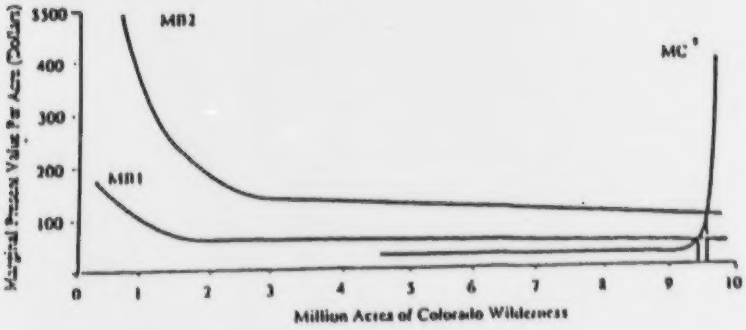
Assumptions	Wilderness Recreation	Logging
Base Case (10% Discount Rate)	3.3	(7.6)
8% Discount Rate	4.3	(8.8)
12% Discount Rate	2.7	(7.3)
Willingness to Pay	1.0	(8.1)
Inclusion of Option & Existence Values	2.6	(7.6)
High Growth In Recreation Demand	4.5	(7.8)
No Growth in Recreation Demand	2.0	(7.4)
Low Lumber Price	3.3	(11.5)
High Lumber Price	3.3	1.8
Recreation/Logging Capability	3.3	(6.6)
Employment Benefits	3.3	(2.1)
Compensation Demanded High Growth in Recreation Demand and Inclusion of Option and Existence Values	6.9	(7.6)

The case study illustrates the strengths and weaknesses of economic evaluation of watershed options. The principle weakness is that the results are highly sensitive to the assumptions made. Indeed, several economic evaluations of the Stein undertaken by different study teams have come to different conclusions. Consequently, economic evaluation does not necessarily give clear results. Second, net benefit calculations obviously exclude numerous other factors relevant to decision makers such as regional unemployment, government revenue and environmental impacts. On the positive side, the case study illustrates that the application of these techniques is feasible and integrates many of the relevant variables in a consistent and comprehensive framework.

Figure 3.

Supply and Demand Curve

for Wilderness



MB1 - Marginal benefits without preservation values.

MB2 - Marginal values with preservation values.

MC^{s}- Marginal costs.

6.3 Provincial Land Allocation

A key land use planning question in British Columbia is deciding the proportion of the land base which should be allocated to each alternative land use. In a recent study, Walsh and Loomis (1984) illustrated how contingent valuation can be used to analyze this question. A survey of residents of Colorado was conducted. Survey participants were shown alternative maps of the state depicting increasing proportions allocated to preservation. They were then asked what they were willing to pay for increasing quantities of wilderness. The resulting values can be used to construct a marginal benefit or demand curve for wilderness as illustrated in figure 3. Two demand curves are shown: one based on only use value and the other including the preservation values (option, existence and bequest value). A cost curve was then estimated based on the opportunity cost of land measured by foregone resource extraction benefits plus the management costs of wilderness. The socially optimal amount of wilderness can then be estimated by the intersection of the marginal benefit and marginal cost curves.

7.0 CONCLUSION

This review indicates that methods for estimating the value of non-market commodities are now widely accepted. The various techniques are clearly feasible and generate information useful for decision making. As the case study of the Stein and the review of contingent value studies illustrate, however, the results vary widely depending on the techniques and assumptions employed. Forecasting future values is particularly difficult given the lack of consistent time series data. Also, there are numerous theoretical issues and challenges which remain unresolved. Problems in valuing market commodities such as forestry are also formidable. Indeed, the range of probable values for forestry were greater than the range for recreation.

Despite these limitations, the use of techniques for non-market valuation provide a consistent and comprehensive framework for analyzing land allocation problems. Several recommendations should be considered to improve the utility of these techniques. First, given the wide latitude available to each analyst to alter assumptions and techniques, it would be useful to develop consistent provincial guidelines for the use of non-market evaluation to ensure consistency and comparability in results. Second, the limitations of the various techniques should be emphasized so that the results can be given appropriate weight in decision making. Third, the province should undertake a number of non-market value studies to establish base-line data useful for land allocation tradeoff analysis.

Bibliography

Anderson, R.J. 1981. "A Note on Option Value and the Expected Value of Consumer Surplus," *Journal of Environmental Economics and Management* Vol. 8, pp. 187-191.

Arrow, K.J. 1986. "Comments" in Ronald G. Cummings, David S. Brookshire and William D. Schulze, eds. *Valuing Environmental Goods*. Totawa, NJ: Rowman and Allanhold.

Arrow, Kenneth J., and Anthony C. Fisher. 1974. "Environmental Preservation, Uncertainty, and Irreversibility," *Quarterly Journal of Economics* Vol. 88, pp. 313-319.

Beardsley, W.G. 1971. "Economic Value of Recreation Benefits Determined by Three Methods," U.S. Forest Service Research Notes, RM-176. Colorado Springs: Rocky Mountain Experiment Station.

Bentkover, Judith D., Vincent T. Covello, and Jeryl Mumpower. 1985. *Benefits Assessment: The State of the Art*. Hingham, Mass.: Kluwer Academic Publishers.

Binkley, Clark S., and W. Michael Hanemann. 1978. "The Recreation Benefits of Water Quality Improvement: Analysis of Day Trips in an Urban Setting." Washington, D.C.: Report to the U.S. Environmental Protection Agency.

Bishop, Richard C. 1982. "Option Value: An Exposition and Extension," *Land Economics* Vol. 58, pp. 1-15.

Bishop, Richard C. and Thomas Heberlein. 1979. "Measuring Values of Extra Market Goods: Are Indirect Methods Bias." *American Journal of Agricultural Economics* Vol. 61, No. 5, pp. 926-930.

Bishop, Richard C., and Thomas A. Heberlein. 1984. "Contingent Valuation Methods and Ecosystem Damage from Acid Rain," Staff paper Series no. 217, Department of Agricultural Economics, University of Wisconsin.

Bishop, Richard C., and Thomas A. Heberlein. 1986. "Does Contingent Valuation Work?" in Ronald G. Cummings, David S. Brookshire, and William D. Schulze, eds., *Valuing Environmental Goods*. Totawa, N.J.: Rowman and Allanheld.

Bishop, Richard C., Thomas A. Heberlein, and Mary Jo Kealy. 1983. "Hypothetical Bias in Contingent Valuation: Results from a Simulated Market," *Natural Resources Journal* Vol. 23, no. 3, pp. 619-633.

Bohm, Peter. 1984. "Revealing a Demand for an Actual Public Good", *Journal of Public Economics* Vol. 24, pp. 135-151.

Bowker, J.M. and J.R. Stoll. 1988. "Use of Dichotomous Choice Non-market Methods to Value Whooping Crane Resource", *American Journal of Agricultural Economics* Vol. 70, pp. 372-381.

Bowden, G.K. 1986. "Economic Implications of Alternative Developments in the Stein River Valley." Report prepared for the Wilderness Advisory Committee, mimeo.

Boyle, Kevin J., Richard C. Bishop, and Michael P. Welsh. 1985. "Starting Point Bias in Contingent Valuation Surveys," Land Economics Vol. 61, pp. 188-194.

British Columbia, Environment and Land Use Secretariat. 1977. Guidelines for Benefit Cost Analysis. Victoria: Province of British Columbia.

Brookshire, David D. et al. 1981. "Experiments in Valuing Public Goods", in K. Smith ed. Advances in Applied Microeconomics. Greenwich, Conn.: JAI Press.

Brookshire, David S., Alan Randall, and John R. Stoll. 1980. "Valuing Increments and Decrements in Natural Resource Service Flows," American Journal of Agricultural Economics Vol. 62, no. 3, pp. 478-488.

Brookshire, David S., B.C. Ives and W.D. Schulze. 1976. "The Valuation of Aesthetic Preferences", Journal of Environmental Economics and Management Vol. 3, No. 4, pp. 325-346.

Brookshire, David S., Don L. Coursey, and William D. Schulze. 1986. "Experiments in the Solicitation of Public and Private Values: An Overview," in L. Green and J. Kasel, eds., Advances in Behavioral Economics. Greenwich, Conn.: JAI Press.

Brookshire, David S., Larry S. Eubanks, and Alan Randall. 1983. "Estimating Option Price and Existence Values for Wildlife Resources," Land Economics Vol. 59, pp. 1-15.

Brookshire, David S., Larry S. Eubanks, and Cindy F. Sorg. 1986. "Existence Values and Normative Economics: Implications for Valuing Water Resources," Water Resources Research Vol. 22, no. 11, pp. 1509-1518.

Brookshire, David S., Mark A. Thayer, William P. Schulze, and Ralph C. d'Arge. 1982. "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches," American Economic Review Vol. 72, no. 1, pp. 165-176.

Brookshire, David S., M. Thayer, J. Tschirhart and W.D. Schulze. 1985. "A Test of the Expected Utility Model: Evidence from Earthquake Risks". Journal of Political Economy Vol. 93, No. 2, pp. 369-389.

Brown, G.M. and H.O. Pollakowski. 1977. "Economic Valuation of a Shoreline", Preview of Economics and Statistics Vol. 59, pp. 272-278.

Burness, H.S., Ronald G. Cummings, A.F. Mehr, and M.S. Walbert. 1983. "Valuing Policies Which Reduce Environmental Risk," Natural Resources Journal Vol. 23, pp. 675-682.

Canada, Treasury Board. 1976. Benefit-Cost Analysis Guidelines. Ottawa: Supply and Services.

Carson, Richard T., and Robert Cameron Mitchell. 1983. "A Reestimation of Bishop and Heberlein's Simulated Market-Hypothetica Markets-Travel Cost Results Under Alternative Assumptions," Discussion Paper D-107, Resources for the Future, Washington, D.C.

Carson, Richard T., and Robert Cameron Mitchell. 1986. "The Value of Clean Water: The Public's Willingness to Pay for Boatable, Fishable, and Swimmable Quality Water," Discussion Paper QE85-08, rev., Resources for the Future, Washington, D.C.

Cesario, Frank and J.L. Knetsch. 1970. "Time Bias in Recreation Benefits Estimates", Water Resources Research Vol. 6, pp. 700-704.

Cesario, Frank. 1976. "Value of Time in Recreation Benefit Studies," Land Economics Vol. 55, pp. 32-41.

Clawson, Marion, and Jack Knetsch. 1966. Economics of Outdoor Recreation. Baltimore: The Johns Hopkins University Press for Resources for the Future.

Coursey, Don L., John Hovis, and William D. Schulze. 1987. "The Disparity Between Willingness to Accept and Willingness to Pay Measures of Value," Quarterly Journal of Economics Vol. 102, pp. 679-690.

Cummings, Ronald G., David S. Brookshire, and William D. Schulze, eds. 1986. Valuing Environmental Goods: A State of the Arts Assessment of the Contingent Method Totowa, N.J.: Rowman and Allanheld.

Desvouages, W. H., V. Kerry Smith, and M.P. McGivney. 1983. "A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvements", EPA-230-05-83-001. Washington, D.C.: Environmental Protection Agency.

Davis, Robert K. 1963. "Recreation Planning as an Economic Problem," Natural Resources Journal Vol. 3, no. 2, pp. 239-249.

Fisher, A., G.H. McLelland, and W.D. Schulze. 1988. "Measures of Willingness to Pay Versus Willingness to Accept", in G.L. Peterson, B.L. Driver and R. Gregory eds., Amenity Resources Valuation. State College, PA: Venture Publishing.

Fisher, Anthony C., and W. Michael Hanemann. 1986. "Option Value and the Extinction of Species," in V. Kerry Smith, ed., Advances in Applied Microeconomics, Vol. 4 Greenwich, Conn.: JAI Press.

Fisher, Anthony C., and W. Michael Hanemann. 1987. "Quasi-Option Value: Some Misconceptions Dispelled," Journal of Environmental Economics and Management Vol. 14, pp. 183-190.

Freeman, A. Myrick III. 1979b. The Benefits of Environmental Improvement: Theory and Practice. Baltimore: The Johns Hopkins University Press for Resources for the Future.

Freeman, A. Myrick III. 1979c. "Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues," Scandinavian Journal of Economics Vol. 81, pp. 154-173.

Freeman, A. Myrick III. 1981. Air and Water Pollution Control: A Benefit Assessment. New York: Wiley.

Freeman, A. Myrick III. 1984a. "The Quasi-Option Value of Irreversible Development," Journal of Environmental Economics Vol. 11, pp. 292-295.

Freeman, A. Myrick III. 1984b. "The Size and Sign of Option Value," Land Economics Vol. 60, pp. 1-13.

Greenly, D.A., R.G. Walsh and R.A. Young. 1985. "Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality", Quarterly Journal of Economics Vol. 100, No. 1, pp. 244-289.

Griliches, Z. ed. 1971. Price Indexes and Quality Change. Cambridge, Mass.: Harvard University Press.

Gunton, Thomas, et al. 1986. Stein River Watershed Resource Evaluation Research Report No. 5, Simon Fraser University, Burnaby, B.C.

Harrison, D. and D.L. Rubinfeld. 1978. "The Distribution of Benefits from Improvements in Urban Air Quality", Journal of Environmental Economics and Management Vol. 5, pp. 313-332.

Haspel, A.E. and F.R. Johnson. 1982. "Multiple Destination Trip Bias in Recreation Benefit Estimation", Land Economics Vol 58, No. 3. pp. 364-372.

Heberlein, Thomas A., and Richard C. Bishop. 1986. "Assessing the Validity of Contingent Valuation: Three Field Experiments," Science of the Total Environment Vol. 56, pp. 99-107.

Hoehn, John P., and Alan Randall. 1987. "A Satisfactory Benefit Cost Indicator from Contingent Valuation," Journal of Environmental Economics and Management Vol. 14, no. 3, pp. 226-247.

Jackson, J.E. 1983. "Measuring the Demand for Environmental Quality with Survey Data", Journal of Politics Vol. 45, pp. 335-350.

Just, R.E. D.L. Hueth and A. Schmitz. 1982. Applied Welfare Economics and Public Policy Englewood Cliffs, N.J.: Prentice Hall.

Kahneman, Daniel and J.L. Knetsch. 1990. "Valuing Public Goods: The Purchase of Moral Satisfaction". Mimeo.

Kahneman, Daniel. 1986. "Comments" in Ronald G. Cummings, David S. Brookshire and William D. Schulze, eds. Valuing Environmental Goods. Totawa, NJ: Rowman and Allanhold.

Knetsch, J.L. 1984. "Legal Rules and the Basis for Evaluating Economic Losses," International Review of Law and Economics Vol. 4, pp 5-13.

Knetsch, J.L. and W. Fleming. 1977. "Resource Development Alternatives, an Evaluation Strategy", Annals of Regional Science Vol. 11, pp. 39-50.

Knetsch, Jack L., and J.A. Sinden. 1984. "Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value," Quarterly Journal of Economics Vol. 94, no. 3, pp. 507-521.

Knetsch, Jack L., and Robert K. Davis. 1966. "Comparisons of Methods for Recreation Evaluation," in Allen V. Kneese and Stephen C. Smith, eds., Water Research. Baltimore: The Johns Hopkins University Press for Resources for the Future.

Krutilla, John V. 1967. "Conservation Reconsidered," American Economic Review Vol. 57, pp. 787-796.

Krutilla, John V. and Anthony C. Fisher. 1975. The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources. Baltimore: The Johns Hopkins University Press for Resources for the Future.

Loomis, J.B. 1987. "Test-Retest Reliability of the Contingent Valuation Method". Department of Agricultural Economics, University of California, Davis. Mimeo.

McConnell, Kenneth E. 1985. "The Economics of Outdoor Recreation," in Allen V. Kneese and James L. Sweeney, eds, Handbook of Natural Resource and Energy Economics Vol. 2. Amsterdam: North-Holland.

McConnell, Kenneth E., and Ivan E. Strand. 1981. "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sport Fishing," American Journal of Agricultural Economics Vol. 63, pp. 153-156.

Mishan, E.J. 1975. Cost-Benefit Analysis. 2nd. ed. London: George Allen and Unwin.

Mitchell, Robert Cameron, and Richard T. Carson. 1984. A Contingent Valuation Estimate of National Freshwater Benefits: Technical Report to the U.S. Environmental Protection Agency Washington, D.C.: Resources for the Future.

Mitchell, Robert Cameron, and Richard T. Carson. 1989. Using Surveys to Value Public Goods, the Contingent Valuation Method. Washington, D.C.: Resources for the Future.

Mitchell, Robert Cameron, and Richard T. Carson. 1985. "Comment on Option Value: Empirical Evidence from a Case Study of Recreation and Water Quality," Quarterly Journal of Economics Vol. 100, no. 1, pp. 291-294.

Moser, David A., and C. Mark Dunning. 1986. A Guide for Using the Contingent Value Methodology in Recreation Studies, National Economic Development Procedures Manual--Recreation, Vol. 2, IWR report 86-R-5. Fort Belvoir, Va.: Institute for Water Resources.

Pearce, D.W. and C.A. Nash. 1981. Social Appraisal of Projects, a Text in Cost-Benefit Analysis. London: MacMillan Press.

Peterson, George L., Beverly L. Driver, and Robin Gregory, eds. Forthcoming. Valuation of Public Amenity Resources an Integration of Economics and Psychology. State College, Pa.: Venture Publishers.

Pope, C.A. and J.W. Jones. 1987. "Value of Wilderness Designation in Utah". Mimeo.

Prince, R.. 1988. "Estimating Recreation Benefits under Congestion, Uncertainty and Disequilibrium". Mimeo.

Randall, Alan, and George L. Peterson. 1984. "The Value of Wildlife Benefits: An Overview," in George L. Peterson and Alan Randall, eds., Valuation of Wildland Resource Benefits. Boulder, Colo.: Westview Press.

Randall, Alan, Berry C. Ives, and Clyde Eastman. 1974. "Bidding Games for Valuation of Aesthetic Environmental Improvements," Journal of Environmental Economics and Management Vol. 1, pp. 132-149.

Randall, Alan, John P. Hoehn, and David S. Brookshire. 1983. "Contingent Valuation Surveys for Evaluating Environmental Assets," Natural Resources Journal Vol. 23, pp 635-649.

Rhoads, Steven E. 1985. The Economist's View of the World: Government, Markets, and Public Policy. New York: Cambridge University Press.

Roberts, J.K., M.E. Thompson, and P.W. Pawlyk. 1985. "Contingent Valuation of Recreation Diving at Petroleum Rigs, Gulf of Mexico," Transactions of American Fisheries Society. Vol. 114, No. 2, pp. 214-219.

Rosen, S. 1974. "Hedonic Prices and Implicit Markets: Production Differentiation in Pure Competition," Journal of Political Economy, Vol. 82, pp. 34-55.

Rowe, R.D., R.C. d'Arge and D.S. Brookshire. 1980. "An Experiment in the Economics of Visibility," Journal of Environmental Economics and Management Vol. 7, pp. 1-19.

Schulze, William D., Ralph C. d'Arge, and David S. Brookshire. 1981. "Valuing Environmental Commodities: Some Recent Experiments," Land Economics Vol. 57, no. 2, pp. 151-169.

Sinden, John A. 1974. "Valuation of Recreation and Aesthetic Experiences," American Journal of Agricultural Economics Vol. 56, pp. 64-72.

Seller, C., J.R. Stoll and J.P. Chavas. 1985. "Validation of Empirical Measures of Welfare Change: A Comparison of Non-Market Techniques," Land Economics Vol. 61, No. 2 pp. 156-175

Sinden, John A., and Albert C. Worrell. 1979. Unpriced Values: Decisions Without Market Prices. New York: Wiley-Interscience.

Smith V. Kerry and William H. Desvousges. 1985. "The Generalized Travel Cost Model and Water Quality Benefits: A Reconsideration," Southern Journal of Economics Vol. 52, pp. 371-381.

Smith V. Kerry. 1987. "Uncertainty, Benefit-Cost Analysis, and the Treatment of Option Value," Journal of Environmental Economics and Management Vol. 14, pp. 283-292.

Smith, V. Kerry, William H. Desvousges, and Ann Fisher. 1986. "A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits," American Journal of Agricultural Economics Vol. 68, no. 2, pp. 280-290.

Sorg, Cindy F. et al. 1985. "Net Economic Value of Cold and Warm Water Fishing in Idaho," Resources Bulletin RM-11, U.S. Forest Service.

Sorg, Cindy F., and Louis J. Nelson. 1986. "Net Economic Value of Elk Hunting in Idaho," Resource Bulletin RM-12, Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service, Fort Collins, Colo.

Stanbury, W.T., Ilan Vertinsky, and H. Thille. 1990. "The Use of Cost-Benefit Analysis to Allocate Forest Lands Among Alternative Uses," Forest Resources Commission Study, mimeo.

Sutherland, R. 1982. "Sensitivity of Travel Cost Estimates of Recreation Demand to the Functional Form and Definition of Origin Zones," Western Journal of Agricultural Economics Vol. 64, 136-141.

Sugden, Robert and Allan Williams. 1978. Principles of Practical Cost-Benefit Analysis. Oxford: Oxford University Press.

Thayer, Mark A. 1981. "Contingent Valuation Techniques for Assessing Environmental Impacts: Further Evidence," Journal of Environmental Economics and Management Vol. 8, pp. 27-44.

Tolley, G.S. and Alan Randall. 1983. "Establishing and Valuing the Effects of Improved Visibility in the Eastern United States", Interim Report to the U.S. Environmental Protection Agency.

Walsh, Richard G. 1986. Recreation Economic Decisions: Comparing Benefits and Costs. State College, Penn: Venture Publishing.

Walsh, Richard G. and John B. Loomis. 1989. "Non-Traditional Public Valuation of Wilderness". in Wilderness Benchmark 1988: Proceedings of the National Wilderness Colloquium. USDA Forest Service General Technical Report SE-51, pp. 181-192.

Walsh, Richard G., N.P. Miller and L.V. Gilliam. 1983. "Congestion and Willingness to Pay for Expansion of Skiing Capacity," Land Economics Vol. 59, No. 2 pp. 195-210.

Walsh, Richard G., John B. Loomis, and Richard A. Gillman. 1984. "Valuing Option, Existence, and Bequest Demands for Wilderness," Land Economics Vol. 60, no. 1, pp. 14-29.

Walsh, Richard G., L.D. Sanders and J.B. Loomis. 1985. "Wild and Scenic River Economics: Recreation Use and Preservation Values," Report to the American Wilderness Alliance.

Water Resources Council. 1983. Principles and Guidelines for Water and Related Land Resources Implementation Studies Washington, D.C.

Weisbrod, Burton A. 1964. "Collective Consumption Services of Individual-Consumption Goods," Quarterly Journal of Economics Vol. 78, no. 3, pp. 471-477.

Wilderness Advisory Committee. 1986. "The Wilderness Mosaic, Report of the Wilderness Advisory Committee," Vancouver, B.C. , mimeo.

Wilman, Elizabeth A. 1980. "The Value of Time in Recreation Benefit Studies," Journal of Environmental Economics and Management Vol. 7, pp. 272-286.

(ECNVALNM)

DRAFT

TOWARD SUSTAINABLE WATER PLANNING AND MANAGEMENT IN BRITISH COLUMBIA

Dr. J.C. Day and J.A. Affum
November 1990

Prepared For The British Columbia Round Table On The Environment And The Economy

PREFACE

"Toward Sustainable Water Planning And Management In British Columbia" was prepared by Dr.J.C. Day and J.A. Affum as part of a project funded jointly by the British Columbia Forest Resources Commission and the British Columbia Round Table on the Environment and the Economy. It is part of a series of background reports dealing with issues which Round Table committees considered important to the development of a sustainable development strategy in British Columbia, and is intended to provide information which will assist the dialogue between the Round Table and the public.

In this context, the Round Table has not endorsed the report. The information provided and conclusions reached are those of the authors.

Lee Doney
Executive Director and Secretary
British Columbia Round Table
On The Environment and The Economy

November 1990

CONTENTS

Figures iii

Sustainable Development 1

Water Management Sustainability 1

A Perspective on Water Management in British Columbia 2

The Water Resource 4
  Streamflow and Snow 4
  Lake, River, and Stream Inventories 5
  Quality 5
  Water Demand and Allocation 6

The Water Allocation System 6
  Jurisdiction 7
  Federal Water Planning Powers 7
  Provincial Legislation 7
    Recognized Water Uses 8
    Duration 8
    Priority 8
    Who is excluded 8
  The Provincial Allocation Process 8
  Conflicting Mandates 10

Offstream Water and Related Land and Resource Management 10
  Hydroelectricity 10
    The Institutional System 10
    Application Procedures 14
    Provincial Review 14
  Environmental and Social Impacts of Hydroelectricity Developments 16
    Landuse and Environmental Effects 16
    Regional Economic and Social Impacts 17
    Electricity Futures 18
  Forestry 19
  Mining 21
  Agriculture 22

Other Instream Uses 24
  Fisheries 24
  Wildlife 26
  Tourism 27
  Recreation 27
  Waste Management and Water Quality 28
  Native Uses 29

Groundwater 30

River Basin Planning 31
  Public Involvement 33

A Summary Assessment..........34
  The Water Act..........35
    A Planning Mandate..........35
    New Priorities..........36
    Transfer of Water Rights..........36
  Community Watersheds..........36
  Hydroelectricity..........37
  Agriculture..........38
  Forestry..........38
  Public Involvement..........38
  Groundwater..........39
  Risk, Uncertainty, and Development Options..........39
  Agency Funding..........39
  River Basin Planning..........40

Integrating Sustainable Development Policies..........41

Recommendations..........42

References..........44

FIGURES

1: The British Columbia System for Adjudicating Water License Requests..........9

2: Major British Columbia Hydroelectric Dams..........11

3: The Energy Project Review Process..........12

4: Interagency Framework for Energy Project Review..........15

SUSTAINABLE DEVELOPMENT

In response to the World Commission on Environment and Economy initiative, Canada adopted as its definition of sustainable development (Canada 1987a):

> the utilization of resources and the environment to optimize economic and other societal benefits today while not damaging prospects for their use by future generations.

At the provincial level, the British Columbia Task Force on Environment and the Economy recommended that a provincial round table on economy and the environment be established and that it should conduct special studies on matters of interest to the round table (B.C. Task Force 1989: 2).

This report considers selected aspects of the current water planning and management system in British Columbia. It examines the B.C. Water Act and associated institutional arrangements for water management. The legislation, allocation agencies, allocation processes, other water management agencies, and results of allocation decisions are evaluated here. The report evaluates the degree to which sustainable management is possible within the current institutional system. In the final section it makes some recommendations to move the province toward sustainability in water and water-related resource management.

WATER MANAGEMENT AND SUSTAINABILITY

Water is a fundamental component of the British Columbia resource base, and is interconnected in all phases of the hydrological cycle: atmospheric, surface, groundwater, and ice. It is essential in suitable quantities for all life forms. It is used for a variety of instream nonconsumptive uses such as navigation, fish, wildlife, recreation, and tourism. And there are a variety of other water and water-derived services which either withdraw water for consumptive uses such as municipal and industrial purposes, agriculture, or for transformation into energy. Along with topography, water controls or influences the location of most human settlements and infrastructure, and has inspired various artistic and cultural expressions.

When viewed from the perspective of sustainability, all of these water uses and related land management issues are interdependent and often competitive. For example, the decision

to permit hydroelectric development often precludes habitat enhancement for some fish species, and certain kinds of recreation, tourism, forestry, agriculture, and wildlife habitat. Or heavy consumptive uses in a drainage basin for one purpose, such as irrigation, often prevent all later potential consumptive uses as well as impair or destroy the potential for other instream uses including fisheries, wildlife, birds, and some forms of recreation and tourism. And pollution is normally detrimental to all water uses and phases of the hydrological cycle.

Because of the interrelated nature of all water uses and users and various sectors of the economy, there is not a unique solution to the mix of uses which will promote sustainability of all resources within the drainages of the province. Rather, sustainable development is an ideal in which mutually interdependent economic, environmental, and social objectives must be balanced. More of one use normally limits or precludes others. As society attempts to choose combinations of resource uses which foreclose as few development options for future generations as possible, all the potentially competing and complementary uses within the watersheds and aquifers of this province need to be considered simultaneously. Such an approach, traditionally called integrated resource management, may require major institutional change in British Columbia.

A PERSPECTIVE ON WATER MANAGEMENT IN BRITISH COLUMBIA

There has been little effort devoted to addressing sustainable water management on a comprehensive basis within British Columbia to the present time. Rather, certain users and uses have been encouraged over time as new socio-economic opportunities emerged. In general, there has not been widespread public discussion of social preferences for alternative water and related land uses. However, under the British Columbia Utilities Commission, the public is given the opportunity to comment from time to time on major questions such as the Site C Dam. In future, local communities and the general public must be given increased opportunities to participate in making these decisions (B.C. Task Force, 1989: 16-17).

Initially water was allocated for mining in the gold rush days of the 19th century. Then irrigation, other agricultural, hydroelectricity, municipal, and industrial uses grew. And these uses were supported by legislation. Stated another way, there has been comparatively little attention paid to the needs of instream water uses for fish, wildlife, recreation, and tourism, as well as water quality and the sustainability of provincial aquifers. As a result of

3. There should be a comparable data base for all potential water uses and users before major allocative decisions are taken for specific basins.

4. Management policies and plans need to be formulated for the major drainage basins and principal aquifers of British Columbia. This process should involve all stakeholders in the areas concerned. To the extent possible, decisions on allocation should be based on consensus (B.C. Task Force, 1989:17). And reasons for allocative choices which are adopted should be made public.

5. A province-wide perspective based on the potential uses of all river basins is needed in arriving at future major allocative decisions concerning sustainability within specific drainages.

6. Future water allocation should be taken in light of irreversible commitments already made in the river basins and aquifers of the province.

If such information and planning processes were available, the province could begin the difficult process of deciding among potential water and resource uses within the provincial drainages. Ultimately, decisions will have to be taken on the acceptable level of water and land uses in light of what each choice means for the sustainability of all other uses.

THE WATER RESOURCE

The current level of intelligence concerning water in British Columbia reflects the historical abundance of the resource. In most areas there have not been prolonged shortages. As a result, little effort has traditionally been devoted to inventorying and managing water other than for specific development projects. Some data bases which do exist are described below.

STREAMFLOW AND SNOW

A jointly funded federal-provincial program is the major source of streamflow information. It consists of almost 600 measuring stations under the direction of the Water Survey of Canada. This network is supplemented by 260 manual snow survey stations and 25 automated stations operated by the B.C. Ministry of Environment and B.C. Hydro. Snow depth and equivalent water amounts are measured monthly from December to May. This is the strongest component of the current water inventory system.

LAKE, RIVER, AND STREAM INVENTORIES

The level of intelligence in these areas is generally inadequate for reliable decision making. Only 300 of 21,000 lakes have been surveyed, mainly in the southern third of the province. Data include physical descriptions, fish present, and productive capability. And roughly 200 rivers and streams of 4000 in the province have been inventoried at reconnaissance level with limited detailed mapping. These surveys are similar to the lake studies with an aquatic habitat component added.

QUALITY

Water quality monitoring is carried out to determine trends in fresh water and groundwater quality. Generally, little detailed information is available on the quantity and quality of groundwater in the province. Surface water quality management is not investigated here.

Acid Rain. This condition is generated by industrial emissions, exhaust from cars and other forms of transportation, ore smelting, natural gas processing, and thermal generation sources (B.C., MOE, 1989). All of these sources make rainfall more acidic than under natural conditions. In heavy concentrations, acid rain can cause esthetic losses, the destruction of forests, fish, tourism, and recreation resources, and the deterioration of building and automobile surfaces. Human health can also be detrimentally affected.

There are comparatively few major acid rain pollution sources in the province. Moreover, the predominant west to east atmospheric movement normally transports such pollutants out of the province. There is a large area in the central part of British Columbia where alkaline lakes and soils are able to chemically neutralize excess acidity from precipitation. However, most of western British Columbia is underlain by granitic bedrock as well as a zone of highly sensitive soils which extend from the southern to the northern border. Both of these areas are highly sensitive to acid precipitation and are also at risk (Technical Committee . . ., 1987: figs. 4-2 and 4-5).

Acid rain has not become a large-scale problem in western Canada and specifically in British Columbia to date (B.C., MOE, 1989: 1). Nevertheless, in an effort to understand and monitor this phenomenon, Environment Canada is operating eight stations and the B.C. Ministry of Environment has additional installations. Data are pooled to detect and prevent serious acid rain problems before they develop in the province.

WATER DEMAND AND ALLOCATION

As a consequence of the poor quality of information that exists on British Columbia's water resource, the capability to support various resource uses, and water commitments in the streams, rivers, and lakes of the province, allocative decisions must continually be made on the basis of incomplete information. Moreover, the provincial water comptroller is forced by the existing Water Act to react to development proposals. Indeed, the act makes no provision for anticipatory planning of the kind that would consider the implications of allocative decisions on the capability and sustainability of complementary and competitive resources within the watersheds.

The B.C. comptroller of water rights has traditionally used a manual system to keep track of water availability and existing licenses within provincial drainages. As of 1990, this system has resulted in about 5,500 of 25,000 subbasins having a possible or known water shortage. In 1989, a major initiative was undertaken to computerize the existing data for about 40,000 active water licenses in the province as well as available flow data by watershed. By the end of 1990, it is expected that this information will be analyzed for the Kootenay Region.

Similar analyses are expected to be available for the whole province by the end of 1991. It is anticipated that the new system will permit an estimation of the dependable flow available in each subbasin as well as the level of allocation of current water licenses cumulatively and by individual uses. This new information system will give the comptroller a better data base than has previously been available to adjudicate requests for new licenses. Eventually, the new data bases may be linked to a computer mapping system so that the spatial patterns of water allocation, surplus, and deficit can be rapidly estimated within large basins.

THE WATER ALLOCATION SYSTEM

JURISDICTION

In the Canadian federal system, authority over water resources is shared by both federal and provincial governments. The "resources amendment" to the 1982 Constitution Act gives the provinces exclusive jurisdiction over many aspects of nonrenewable natural resources, including water (Percy, 1984: 103). The provinces exercise propriety rights over water resources and, therefore have the authority to legislate on all aspects of water supply, use, pollution control, hydroelectric and nonnuclear power development, irrigation, and recreation (Canada, 1987b: 11).

The federal government is responsible for fisheries, navigation, federal lands, some specific aspects of environmental protection, Indian and northern lands, and interprovincial and international water management. As the provinces delegate authority to local and regional governments, three or sometimes four levels of jurisdiction are involved, to some degree, in managing water resources. There is, therefore, considerable overlap of functions, which often leads to conflicts among the governments (Canada, 1985a). Further, several agencies at each level of government have interests in, and some responsibility for, water planning.

FEDERAL WATER PLANNING POWERS

The constitution provides for exclusive federal jurisdiction over a variety of matters that are related to water management. These include fisheries, navigation, relations with foreign governments, federal lands, Aboriginal people, and some others which limit the provinces' authority over water.

In 1970, the federal government attempted to deal more broadly with fresh water planning and management by adopting the Canada Water Act, among others. Part I of the act provides a much broader scope for federal activities than was previously considered by permitting it to enter into agreements with provincial governments for conducting research and water inventories, formulating comprehensive water management plans, and designing and executing projects. Under the act, Environment Canada has worked cooperatively with the B.C. Ministry of Environment (MOE) on a variety of initiatives. These include Okanagan Basin planning and implementation, Fraser River upstream storage planning, Fraser estuary planning, and Thompson Basin preplanning. By far, the most ambitious is the Lower Fraser Valley flood control measures. Recently, a cooperative flood control mapping program has also been initiated.

PROVINCIAL LEGISLATION

The Water Act (1979c) regulates water allocation in the province. It is based on the prior appropriation, or "first in time, first in right" legal doctrine. Allocation is by the licence or permit system. Among other things, the act defines the priority among water users, who can hold a water licence, and its duration.

Recognized Water Uses. Under section 6, the following are eligible for water permits: an owner of land or a mine, holders of a certificate of convenience and necessity from the provincial government, municipalities, districts, and B.C. Hydro.

Duration. Licences are granted for an indefinite period as long as the holder pays the fees, and complies with the terms and conditions of the licence (sect. 20).

Priority. Among users of the same stream, priority is determined by the licensing date. For the same date, the priority, in decreasing order of importance is domestic use and sanitation; fire prevention; municipal; medicinal and high temperature waters; irrigation; mining; industrial; electricity or other forms of power; earth and rock moving; storage; fish and wildlife conservation; conveying water for licensees; and the diversion, impoundment, or drainage of water to protect or develop park land (sect. 12).

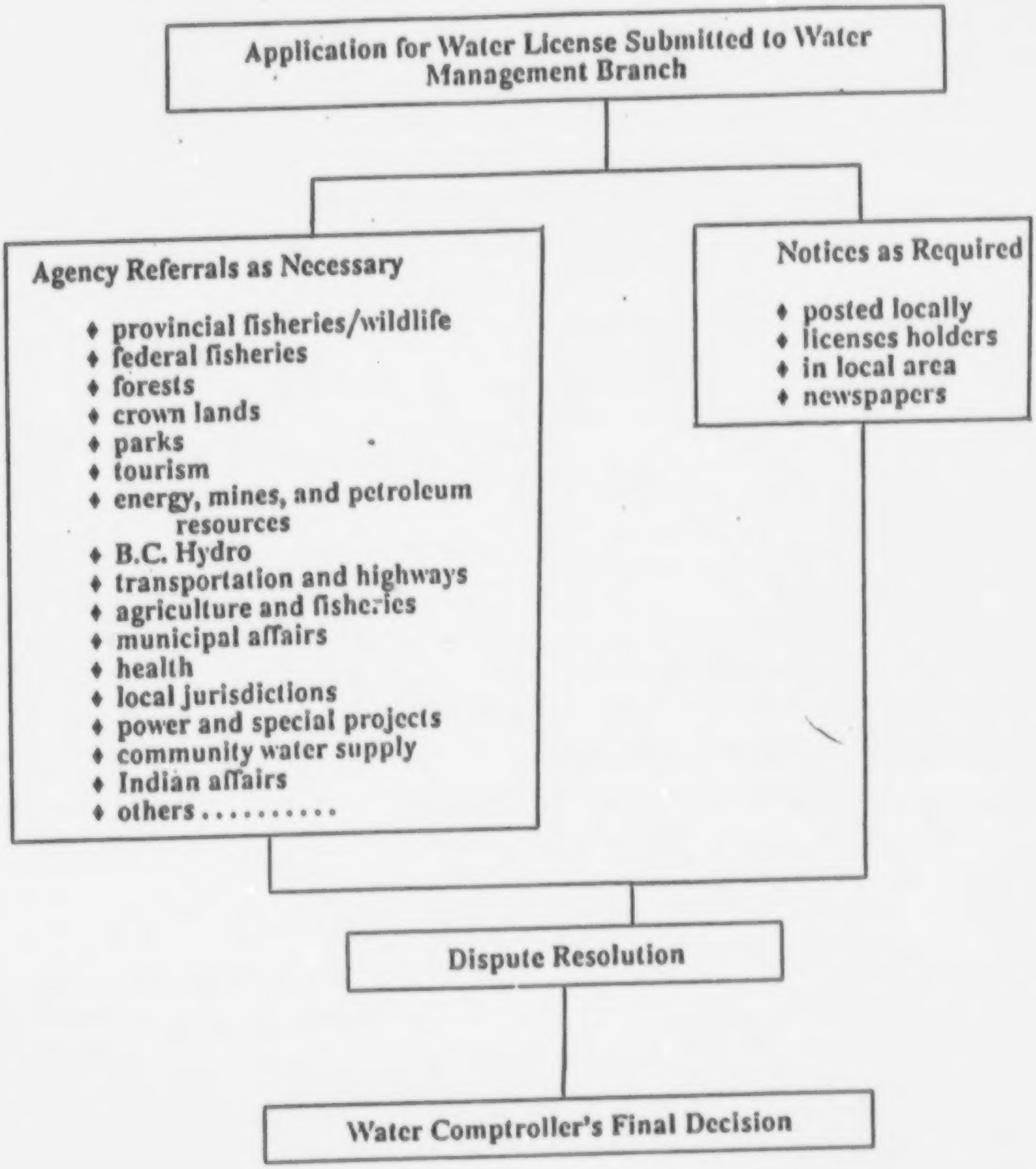
Who is excluded. The act is concerned primarily with offstream water use. With the exception of hydroelectric power generation, it does not address instream requirements, nor does it make provision for accommodating other interests. Thus the more recent water uses, such as recreation, tourism, fish, wildlife, and environmental esthetics, were not considered as worthy of water allocation when the act was proclaimed in 1979.

THE PROVINCIAL ALLOCATION PROCESS

Applicants for water licenses submit proposals to the Water Management Branch of the Ministry of Environment. The Water License Administration unit of the branch circulates proposals to interested federal and provincial agencies, as necessary, as well as notifying affected water users both upstream and downstream of the proposed use area (fig. 1). New applications are posted locally and advertised in newspapers if required.

In attempting to resolve objections over requests for water licenses, the comptroller is guided by several criteria. Senior water rights must be protected and sufficient water must be available most years before additional water allocations can be granted. When criticism is received relating to a request for water, the applicant is put in contact with objectors to determine if a design modification or mitigation measure can resolve the concerns. But in the final analysis, the current Water Act compels the comptroller to issue a license if it is for uses approved in the act. As a consequence, all of the water can be allocated to the approved consumptive uses to the detriment of potential instream requirements for fish, wildlife, recreation, and tourism.

Figure 1. The British Columbia System for Adjudicating Water License Requests.


Application for Water License Submitted to Water Management Branch
Agency Referrals as Necessary
♦ provincial fisheries/wildlife
♦ federal fisheries
♦ forests
♦ crown lands
♦ parks
♦ tourism
♦ energy, mines, and petroleum resources
♦ B.C. Hydro
♦ transportation and highways
♦ agriculture and fisheries
♦ municipal affairs
♦ health
♦ local jurisdictions
♦ power and special projects
♦ community water supply
♦ Indian affairs
♦ others ....
Notices as Required
♦ posted locally
♦ licenses holders
♦ in local area
♦ newspapers
Dispute Resolution
Water Comptroller's Final Decision

CONFLICTING MANDATES

There are real and potential conflicts in provincial mandates for water administration and use. For example, the promotion of agrochemicals by the Ministry of Agriculture and Fisheries to increase productivity may be at variance with the Ministry of Environment's goal of environmental protection. Similarly, dam construction to make possible hydroelectricity generation, and clear-cut logging to reduce timber harvesting costs, both may impact negatively on instream uses such as fish habitats, wilderness, and tourism values. To set compatible water management goals, all resource agencies and the private sector must adopt the objective of sustainable development. They must also adapt their water uses to meet new social objectives.

OFFSTREAM WATER AND RELATED LAND AND RESOURCE MANAGEMENT

HYDROELECTRICITY

Hydroelectricity is a cornerstone of the British Columbia economy. Electricity generated from falling water by B.C. Hydro is mainly derived from two drainages. Four dams on the Columbia River system--the Mica, Revelstoke, Seven Mile, and Kootenay Canal--produce on average 22,130 GWh annually, or 47.6% of the utility's hydroelectric energy. The Shrum and Peace Canyon dams on the Peace River account for 16,500 GWh, or 35.5%. All other drainages contribute the remaining 7820 GWh, or 16.8% (fig. 2). In total, the province has 9637 MW of dependable capacity, 99.9% of which is derived from hydroelectric generation (B.C. Hydro, 1989a: append. II, p. 13). The authority's revenue in 1988 was $1.7 billion and its net income $25 million.

The Institutional System

Four major actors play important roles in the decision to authorize new hydroelectric projects which have a profound impact on the affected watersheds. These are summarized below.

B.C. Cabinet. The provincial cabinet is directly involved in fundamental policy questions such as prebuilding a large hydroelectric project for energy export, or the desirability of inviting private enterprise firms to develop hydroelectric projects (fig. 3). The ministers of energy, mines and petroleum resources and environment implement cabinet policy on such matters. Three related institutions play a variety of roles in operating the system. The Energy Policy Branch of the ministry of energy, with other provincial bodies, decide how development applications will be handled.

Figure 2. Major British Columbia Hydroelectric Dams

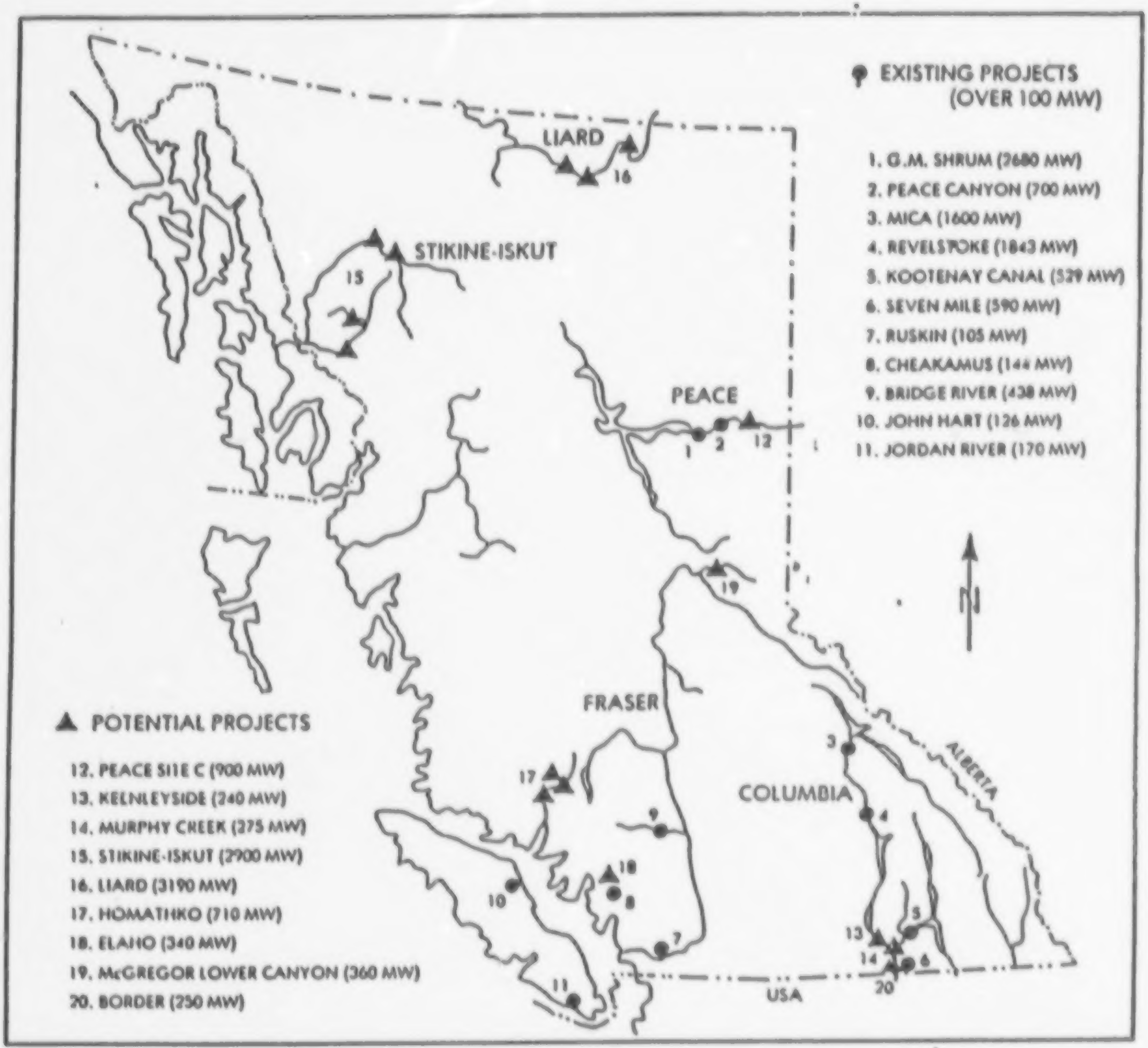
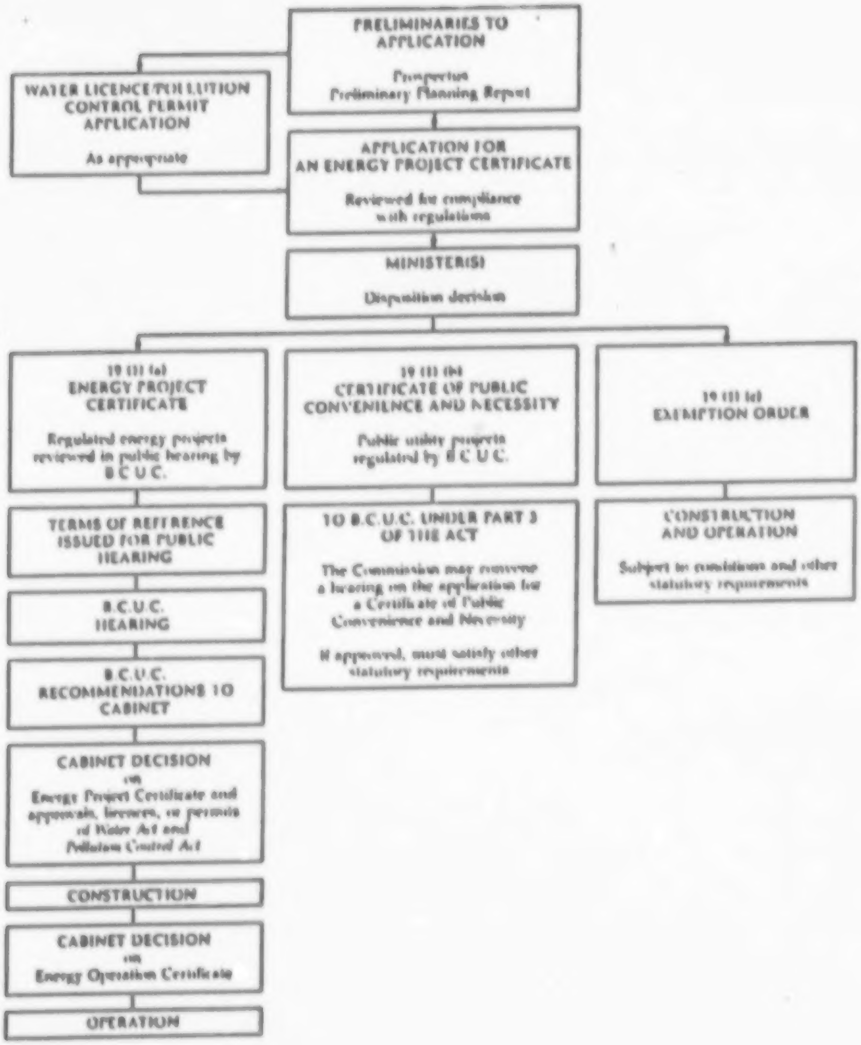

EXISTING PROJECTS (OVER 100 MW)
1. G.M. SHRUM (2680 MW)
2. PEACE CANYON (700 MW)
3. MICA (1600 MW)
4. REVELSTOKE (1843 MW)
5. KOOTENAY CANAL (529 MW)
6. SEVEN MILE (590 MW)
7. RUSKIN (105 MW)
8. CHEAKAMUS (144 MW)
9. BRIDGE RIVER (438 MW)
10. JOHN HART (126 MW)
11. JORDAN RIVER (170 MW)
LIARD
16
STIKINE-ISKUT
15
PEACE
1
2
12
19
N
FRASER
COLUMBIA
ALBERTA
17
9
18
8
10
7
11
3
4
5
13
14
6
20
USA
POTENTIAL PROJECTS
12. PEACE SITE C (900 MW)
13. KEENLEYSIDE (240 MW)
14. MURPHY CREEK (275 MW)
15. STIKINE-ISKUT (2900 MW)
16. LIARD (3190 MW)
17. HOMATHKO (710 MW)
18. ELAHO (340 MW)
19. McGREGOR LOWER CANYON (360 MW)
20. BORDER (250 MW)

Figure 3. The Energy Project Review Process[a].


PRELIMINARIES TO APPLICATION
Prospectus
Preliminary Planning Report
WATER LICENCE/POLLUTION CONTROL PERMIT APPLICATION
As appropriate
APPLICATION FOR AN ENERGY PROJECT CERTIFICATE
Reviewed for compliance with regulations
MINISTER(S)
Disposition decision
19 (1) (a)
ENERGY PROJECT CERTIFICATE
Regulated energy projects reviewed in public hearing by B.C.U.C.
19 (1) (b)
CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY
Public utility projects regulated by B.C.U.C.
19 (1) (c)
EXEMPTION ORDER
TERMS OF REFERENCE ISSUED FOR PUBLIC HEARING
B.C.U.C. HEARING
B.C.U.C. RECOMMENDATIONS TO CABINET
CABINET DECISION
on
Energy Project Certificate and approvals, licences, or permits of Water Act and Pollution Control Act
CONSTRUCTION
CABINET DECISION
on
Energy Operation Certificate
OPERATION
TO B.C.U.C. UNDER PART 3 OF THE ACT
The Commission may convene a hearing on the application for a Certificate of Public Convenience and Necessity
If approved, must satisfy other statutory requirements
CONSTRUCTION AND OPERATION
Subject to conditions and other statutory requirements

---

[a] From B.C., Energy, Mines and Petroleum Resources, 1982: 7.

British Columbia Utilities Commission. The province adopted an integrated approach to approval procedures for major energy projects and export of energy from the province in the Utilities Commission Act of 1980 (B.C., Revised Statutes. 1980). With revisions, it remains in effect today. Under certain circumstances, under the act, the province retained the power to review and certify the construction and operation of major energy projects. The act provides for the regulation of public utilities, including B.C. Hydro, by the British Columbia Utilities Commission (BCUC). The commission reviews and certifies projects which generate, use, store, transmit, or export large quantities of energy. BCUC may also rule not only on a project but also on whether approval should be granted under the Waste Management Act and the Water Act at the same time (*Ibid*. s.20(1)(2)a). A fundamental characteristic of the British Columbia regulatory regime is the strong discretionary control which the provincial government retains over the entire process (Barton 1987: 61).

Over ten years of operation, the B.C. Utilities Commission has emerged as a fair and impartial forum in which a broad range of questions concerning the social utility of proposed energy projects can be publicly reviewed. Although the answers received from such an institution depend largely on the values and political independence of its members, to date the commission's effectiveness and impartiality from government influence can not be questioned. It is important to note in this regard that the government retains control over the selection of the chairman and commissioners for such reviews. The major constraint on BCUC hearings is the range of questions it is asked to address by the provincial government.

In the Site C reference, the value of an independent assessment of B.C. Hydro's proposed projects was clearly established. Although the commission is commonly criticized for taking too long to reach a decision, and for conducting reviews which are too costly, it has already saved the province hundreds of millions of dollars in unnecessary interest payments. In addition, electricity rates are lower today for all consumers than would have been experienced had the commission not rejected the unnecessary $3.2 billion Site C dam proposed by B.C. Hydro in 1983.

B.C. Hydro. The final actor is the British Columbia Hydro and Power Authority. Among other things, the utility plans, constructs, and operates hydroelectric projects for the province. It was given a broad mandate to carry out policies of the provincial cabinet under the Hydro and Power Authority Act (B.C., Revised Statutes, 1979a). There are few restrictions on the powers of the authority (sects. 12, 16, 41, 42). However, the province regulates it, by making statutory provisions of other provincial acts applicable to the authority. These include the Environment Management Act, the Heritage Conservation Act, the Utilities Commission Act, the Water Act, and the Waste Management Act (sect. 52(5)). Its subsidiary company, POWEREX, markets power and energy to the United States. The interrelationship of these bodies is described more fully below.

Application Procedures

An application for an energy certificate under section 18 of the Utilities Commission Act is made to the minister of Energy, Mines and Petroleum Resources. At the same time, applications for a water permit are submitted to the Water Management Branch of the Ministry of Environment (B.C., 1979b) (fig. 3).

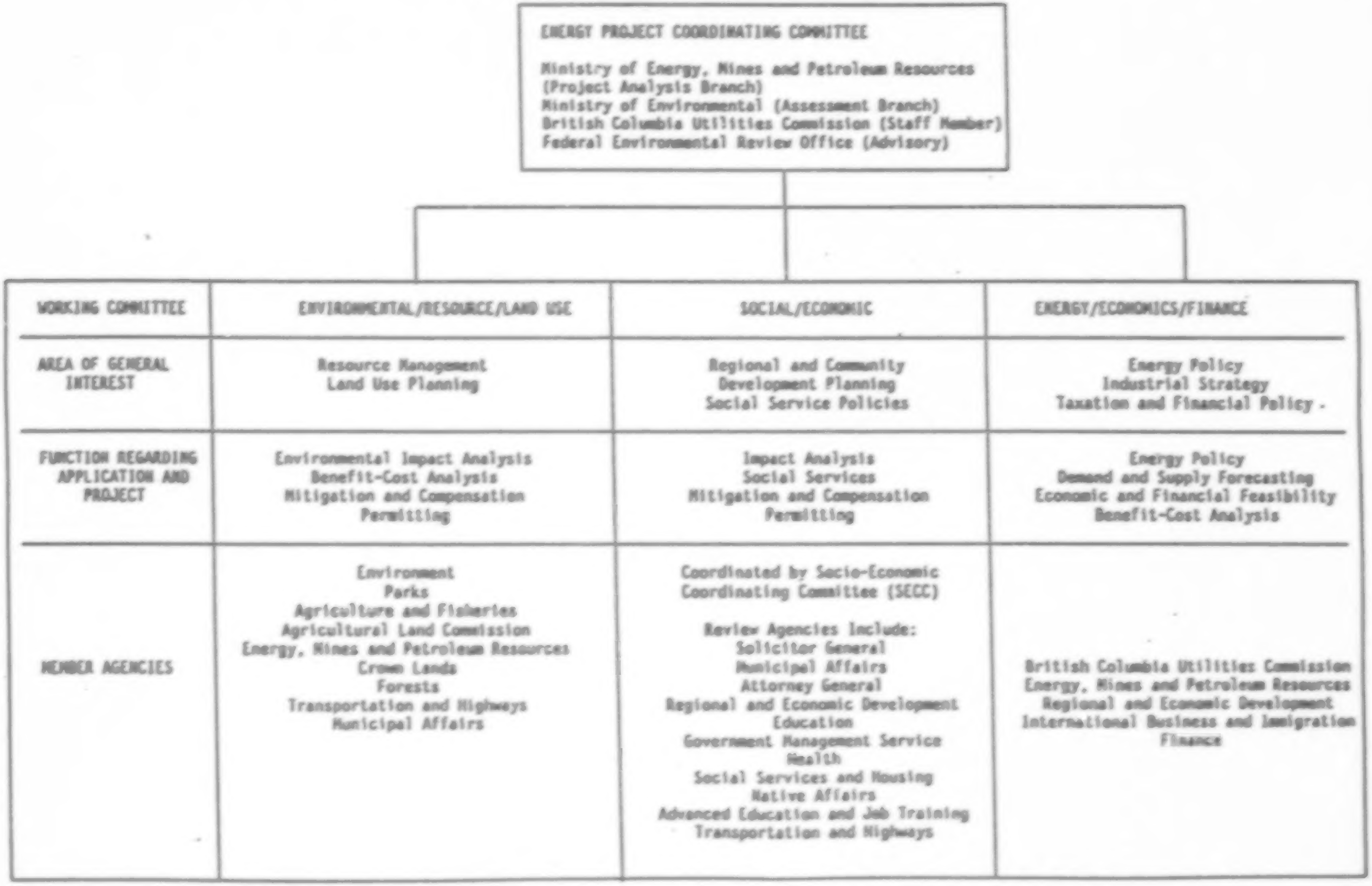
Provincial Review

A comprehensive referral process has been established by the provincial government to coordinate the work of all agencies involved in the review of preliminary studies and applications (fig. 4). This process is currently being revised. The key agency in the evaluation of regulated projects is the Energy Project Coordinating Committee (EPCC). It is composed of representatives from the ministries of energy, environment, and the utilities commission. Not included in the committee are tourism, fisheries, forestry, agriculture, and municipalities. This body coordinates reviews and advises the ministers. Although federal agencies have not normally been involved in these proceedings, mechanisms are currently being created to facilitate this integration.

Working Committees. Three additional bodies coordinate provincial concerns related to environment, resource, and land use issues; social and economic matters; and energy, economics, and financial questions (fig. 4). The committees have seldom been used during the 1980s because of a provincial surplus of electricity and the lack of interest in new energy projects. During 1989 these committees were used frequently in the review of private power proposals.

Permission to use water for hydroelectric generation is obtained by license issued under the Water Act (B.C., 1979c) by the comptroller of water rights of the Ministry of Environment. Anyone holding a certificate of public convenience and necessity from the utilities commission may hold such a license (sect. 6). In the past, the comptroller notified all persons whose rights, or water license, would be affected by a request for a new license (B.C., 1988: sects. 32, 33). New procedures are

Figure 4. Interagency Framework for Energy Project Review.[a]



ENERGY PROJECT COORDINATING COMMITTEE

Ministry of Energy, Mines and Petroleum Resources
(Project Analysis Branch)
Ministry of Environmental (Assessment Branch)
British Columbia Utilities Commission (Staff Member)
Federal Environmental Review Office (Advisory)

WORKING COMMITTEE	ENVIRONMENTAL/RESOURCE/LAND USE	SOCIAL/ECONOMIC	ENERGY/ECONOMICS/FINANCE
AREA OF GENERAL INTEREST	Resource Management Land Use Planning	Regional and Community Development Planning Social Service Policies	Energy Policy Industrial Strategy Taxation and Financial Policy
FUNCTION REGARDING APPLICATION AND PROJECT	Environmental Impact Analysis Benefit-Cost Analysis Mitigation and Compensation Permitting	Impact Analysis Social Services Mitigation and Compensation Permitting	Energy Policy Demand and Supply Forecasting Economic and Financial Feasibility Benefit-Cost Analysis
MEMBER AGENCIES	Environment Parks Agriculture and Fisheries Agricultural Land Commission Energy, Mines and Petroleum Resources Crown Lands Forests Transportation and Highways Municipal Affairs	Coordinated by Socio-Economic Coordinating Committee (SECC) Review Agencies Include: Solicitor General Municipal Affairs Attorney General Regional and Economic Development Education Government Management Service Health Social Services and Housing Native Affairs Advanced Education and Job Training Transportation and Highways	British Columbia Utilities Commission Energy, Mines and Petroleum Resources Regional and Economic Development International Business and Immigration Finance

[a] From: B.C., Energy, Mines and petroleum Resources 1982:11.

currently being formulated to allow all interested government agencies to also comment on such applications.

The issuance of water licenses is profitable for the Province of British Columbia. For example, in the 1988/1989 fiscal year, fees from all water licenses were $247 million. Of this, more than $244 million were from major power producers.

Environmental and Social Impacts of Hydroelectricity Development

A great variety of interests are directly or indirectly affected when a new dam blocks the flow of a river. The hydroelectricity produced is environmentally clean compared to hydrocarbon and nuclear energy sources. But a variety of other effects, mainly negative, are induced and most of these are experienced in the project area. Some of the most common of these, as described in the Site C Report (BCUC 1983) and other sources (Baxter and Glaude 1980), are summarized below.

Landuse and Environmental Effects. Based on 1986 estimates, the Site C Project would affect 6000 ha, 4600 ha of which would be flooded. Of this, 3000 ha are agricultural land with a social value of $59.8 million calculated at an 8% discount rate (B.C. Legislation Assembly, 1981). In addition, 1700 ha of forestry land would also be inundated with a social loss of less than $1 million. Traditionally, the timber in reservoirs is lost to drowning although it would be cleared in the case of the Site C dam. River-based recreation losses are estimated at $6.9 million; game and nongame wildlife losses are $2.8 million. The economic effect on recreational fishery could not be estimated because of insufficient data.

There could be significant climatic changes in the vicinity of the reservoir including increased fog and humidity which might adversely affect farming and transportation. In addition, earthquakes are often induced in regions with well-developed faulting systems where loading associated with the weight of a new dam and accumulated water can cause crustal instability and in some cases movement (U.S. National Academy of Sciences 1972).

Water quality is often degraded downstream of a new dam as a result of the effect of construction activities. This can have a detrimental effect on downstream water users and degrade fish habitat. Mercury methylation now appears to be ubiquitous in newly created reservoirs. Prolonged submergence of soils and vegetation causes bioaccumulation of mercury in the organisms of an affected food chain. This often causes the level of mercury in predatory fish species to exceed the safe level for human consumption. In special circumstances where hydroelectricity generation is based in whole, or in part, on water directed from one drainage to another, artificial diversion channels can permit the passage of unwanted fish species, diseases, and parasites to the detriment of indigenous fauna and flora. In addition, reservoir instability may be induced in reservoir and stream banks where changes in soil moisture content can cause slumping. In areas of natural instability, there could be severe anthropogenic hazards if large landslides enter reservoirs and cause tidal waves above and below a dam.

Heritage and mineral resources are often lost due to inundation. Although field surveys and recovery programs are possible to remove valuable artifacts and mineral deposits prior to inundation, adequate archaeological surveys are seldom conducted.

Regional Economic and Social Impacts. A major positive short-term effect of new dams is the substantial amount of work created over a prolonged period in the project area. In the Site C case, 5400 person years of employment are anticipated over 7-years. Depending on the share of work given to regional residents, this can account for the major positive benefit of such an undertaking in offsetting the biophysical disruption, losses, and social inconvenience. To ensure that potential local benefits are maximized, aggressive long-term training programs for local residents and Indian band members are necessary long before construction begins, as has been practiced in Quebec and Manitoba (Day and Quinn, 1991). There must also be a commitment by the hydro authority to train local residents to operate and maintain the project when it is completed

Local communities which must house the itinerant component of the construction work force often experience increased costs for water, sewage, schools, and the provision of other services. But the major social impacts are felt by the families who lose their homes, land, and livelihoods. Native bands who practice a subsistence lifestyle are particularly vulnerable to the negative effects of damming, particularly if there are other major disturbances related to settlements, transportation, or industrialization in that area.

Traditionally, hydroelectric authorities have concentrated on generating and distributing electricity from dam projects: there has been little or no effort to ameliorate negative effects. Increasingly, the wide range of negative biophysical and social impacts associated with new hydroelectric projects is being recognized. Compensation, mitigation, and monitoring are being undertaken to correct these problems to the extent possible. Currently, it is recommended that monitoring be carried out by an independent commissioner with a small staff and the authority to issue orders to the hydro authority, liaise closely with government agencies, and be accessible to the affected publics (BCUC, 1983).

Electricity Futures. Sustainability and river basin management are closely interrelated. In an undisturbed state, rivers provide sustainable habitats for fish and wildlife. They also contribute to the enchantment and mystique of the province for millions of visitors in search of an experience in undisturbed landscapes. As industrialization inexorably occurs to satisfy a variety of legitimate needs, the sustainability of various symbiotic natural resource processes has historically been systematically diminished. The process of river damming is one of the most ecologically disruptive forms of industrialization in operation today. For this reason, careful proactive planning is needed to ensure that socially acceptable decisions are taken concerning the future use of the provincial rivers.

To the present time, hydroelectric disturbance of the major provincial river systems has been largely restricted to river basins in the southern half of the province. Fortunately, many major river systems, or large tributaries, remain in a free-flowing condition. However, the province has never held public forums to make people aware of the variety of resource values available in the provincial river systems. Nor have the diverse array of affected interest groups been given the opportunity to comment publicly on their preferences for future river development options for energy or other uses.

B.C. Hydro recently prepared a twenty-year plan of its preferred development options, and a tentative sequence of projects (B.C. Hydro 1989a: 41-45). Under the hydroelectric scenario, none of the major provincial drainages would be spared over the long term in this vision. Indeed, if past practice were to continue, there is a real danger that all of the major basins in the province could be successively dammed for electricity without ever holding public hearings on the implications of potential cumulative development options for a sustainable provincial economy.

Over the following year B.C. Hydro adopted an entirely different, and progressive energy development policy (B.C. Hydro, 1990). Its new strategy is to minimize adverse natural and social environment impacts in the process of generating and supplying electricity efficiently. Given this new perspective, its supply priorities were dramatically altered. Increased efficiency of energy use and existing energy generation facilities and coordination of operations with other utilities and companies became the preferred development options. These were followed by small hydro projects, woodwaste, fuel cells, and gas. Of much lower importance were large hydroelectricity options on the Peace and Columbia systems, and finally the undeveloped basins of the province, among others. As a result of this shift in emphasis, the river basins of the province were given a short-term reprieve. This time should be used to investigate the opportunities and needs for sustaining other potential water users in the province.

FORESTRY

The forest ecosystem supports the resource base necessary for the development and growth of a variety of water and forest-based activities and industries. Forestry resources have traditionally been, and continue to be, fundamental to the British Columbia economy. The Ministry of Forests is empowered by the Forest Act to allocate timber, and to manage provincial forests, which constitute about 85% of the area of the province (B.C., 1987a). The act also empowers the Forest Service to manage forest and range resources in a way that would enhance the development of related natural resources, including water. Through its integrated resources management program, the ministry works with other agencies, resource industries, and the general public in setting management guidelines and standards (*ibid.*).

However, some forestry management practices, including road construction, logging, slash-burning, and other postlogging operations, have serious environmental impacts. Water quality and timing of flow, soil erosion, fish and wildlife production, habitat protection, and environmental esthetics can all be negatively affected by forest management. Such effects have generally been considered social development costs. But with the growing public concern over environmental protection and ecologically sound forest management practices, such an accommodating view may not always prevail.

Research suggests that there is a strong and predictable inverse relationship between vegetative cover and water yield. World-wide catchment experiments monitored in the USA show that in clear-cuts of over 10 hectares, a 10% reduction in forest cover causes about 25 to 40 mm increase in mean annual water yield in deciduous hardwoods and conifers respectfully (Bosch and Hewlett, 1982). In northwestern USA, an increase of up to

660 mm was observed (*ibid.*: 18). The study also showed that there is no noticeable hydrologic response to logging if a clear-cut is less than 20% of the forested area of a watershed.

A preliminary B.C. Ministry of Forests study in the Penticton area also shows that when 30% of the forested area is clear-cut, there is a significant effect on water yield (B.C. Forestry Association and Okanagan-Similkameen Park Society, 1989). Total water yield increased by 21%, and the annual peak flow occurred 13 days earlier. This increase in yield and timing may not be desirable, especially in the dry interior. High flow rates could lead to water quality degradation; and early runoff reduces groundwater recharge and makes water less available later.

In an effort to reconcile the needs of forestry with those of other officially recognized water resource uses, the ministry is developing watershed sensitivity rating guidelines for coastal watersheds (B.C., 1987b). In studying the effects of logging practices on a watershed, the ministry is attempting to establish some relationships among water-based resources. Where there are observed detrimental effects, the ministry can determine the capability of a watershed to recover from the degradation, and then attempt to alter harvesting strategies.

If forestry practices are to better protect the integrity of water and related resource uses, new management strategies are required. These include:

a. placing greater emphasis on integrated resources management. There should be greater cooperation among the Forest Service and other agencies, particularly MOE, in resource management programs;
b. developing guidelines on the use of conflict resolution in resource allocation, in cooperation with other resource users;
c. collaborating in research with academic and other research institutions, to establish the effect of various forest management practices on watershed protection, water quality and quantity, esthetics, and fisheries and wildlife habitat;
d. determining the time span before the hydrology of a logged area returns to the condition of an undisturbed forest, and
e. promoting early public involvement in managing emerging issues such as determining the trade-off between logging and wilderness preservation.

It is expected that the B.C. Forest Resources Commission will make recommendations in all of these areas.

MINING

Historically, mining for coal and base metals has had a detrimental impact on water quality and instream uses such as fisheries, recreation, and tourism. In extreme cases, degradation has been so severe that other uses were totally precluded long after the mines have closed. With the adoption of the coal and metal mine review processes in the 1970's and subsequent regulatory improvements, however, the detrimental water-quality impacts of this industry have progressively been controlled. However, the legacy of inadequate control and enforcement of permits in the past will continue into the foreseeable future. Currently, water licenses receive close scrutiny and the threat to surface water is clearly recognized, especially from acid mine drainage. The current initiative to adopt provincial legislation to cover all aspects of the mine approval process, including exploration will further strengthen water quality protection.

A continuing source of conflict has been the negative effects of mine development on community watersheds. Forestry-related complaints are also commonplace in these areas. A coordinated initiative is currently being developed which will ensure more sensitive mining policies for application in the more than 300 designated community watersheds in the province (B.C., 1990a; B.C., 1990b: 18;). Under the new policy, it is intended that all resource developments in these areas must conform to integrated watershed management plans which will be prepared by the Ministry of Environment and the Ministry of Forests. However, only three such plans have been finalized, and 8 are nearing completion. Approximately 40 other community watersheds require plans but these have not been started.

From the perspective of the mining industry, the major water management problem which has been experienced is the excessive length of time which is sometimes required for a decision on a request for a water license from the Ministry of Environment. This reflects the obsolete data management system and low staffing levels in the Water Management Branch. It is expected that the new data management system being developed will help shorten the time required to receive a water license in future, although the number of personnel available to do the work remains a problem. Understandably, companies become anxious when delays occur because of the high cost of establishing a new mine. However, a mine has never been refused in the province on the basis of water shortage, and interim licenses have been used effectively to bridge the gap.

In summary, lack of regulations and enforcements in mining have traditionally had a detrimental impact on water quality. The introduction of regulations over the past fifteen years has progressively brought this industry under tighter control, and reduced the risk of future environmental impairment. However, sensitive resource management practices have been difficult to achieve in the community watersheds on crown lands in British Columbia. The major complaints have been associated with mining and forestry operations. This area of integrated water and land management requires a substantially greater level of personnel if sustainable environmental quality acceptable to local residents is to be achieved.

AGRICULTURE

Agriculture is an important water user in British Columbia. In 1988, for example, of 900,000 hectares (ha) cultivated, about 12% (110,000 ha) were irrigated. Of this, 40% was supported by storage water. Agricultural water licenses returned $740,000 to the province and the industry accounts for 14% of the provincial gross domestic product (B.C., 1989b).

The goal of agricultural water management is to remove water-related constraints to crop and animal production. Emphasis, therefore, is on irrigation, drainage, livestock watering, and soil erosion control (Canada, 1990: 22). Agriculture in British Columbia is diverse, and is an important socioeconomic activity in the southern interior, and to a lesser extent in the lower mainland. In the former, irrigation is critical because the region is semiarid, with less than 35 mm annual precipitation. The water supply may further be limited if the groundwater is salty. Irrigation reduces late season streamflow needed for other uses. Thus agricultural production in such areas is limited by inadequate water resources. Conversely, in the lowlands of the south coastal region, such as Boundary Bay, the constraint is excessive water in the root zone. Here, drainage is the major concern.

Modern agriculture is intensive, requiring massive use of agrochemicals. It involves the application of fertilizers to supplement plant nutrition; organic and inorganic amendments to improve soil quality; and biocides to control weeds, insects, and other pests. These practices, important as they are in increasing agricultural production, may be major sources of water pollution.

Anthropogenic water pollution is caused by both point as well as nonpoint sources. Runoff and seepage from farmlands are often high in chemicals, and threaten surface and groundwater quality (CAST, 1985). Nitrogen, and other plant nutrients often cause lake eutrophication, and reduce the capability of the water resource to serve municipal, fisheries, recreational, and other uses (O'Riordan, 1976). In humid regions, contamination is low because of large quantities of rainfall relative to the chemicals. In dry regions, the natural precipitation is supplemented by irrigation water, which invariably contains dissolved salts.

Inorganic soil additives include liming materials that reduce soil acidity, acidifying materials to increase the acidity of alkaline soils, and gypsum which increases the entry rate of water in sodic soils. Organic matter includes soil residues, food processing wastes, animal manures, and sewage sludges. They are valuable in agriculture as soil conditioners and fertilizers. The principal concerns about the possible effects of these additives on water quality are the excessive levels of nitrogen associated with outdoor animal feeding operations, and bacterial contamination.

The Pesticide Control Act, and the Waste Management Act regulate the storage, transport, application, and disposal of pesticides and discharge of toxic chemicals. However, these legislations are inadequate in dealing with other agricultural activities which may negatively impact on water quality. Although the Pesticide Control Act proscribes direct pollution from farm activities, it does not address indirect pollution such as seepage and runoff.

The British Columbia Ministry of Agriculture and Fisheries is aware of the need for a more sophisticated approach to water planning and management for agriculture and other water uses in the province. It is in the process of establishing a code of practice which would specify acceptable on-farm water management policies. Committees representing the agricultural community would also be created to adjudicate water-related complaints directed at the agricultural community. While such a regulating body would be a useful innovation to promote education and settle disputes, it should not be permitted to delay rapid regulatory action by the Ministry of Environment if persistent or serious water quality and or quantity problems are involved.

Allocation of water among agriculture and other uses, and protection of water quality from farm practices, are important water management issues. For sustainable water and related land management, the following are required:

a. more restrictive provincial legislation and stricter codes on manure, herbicide, fertilizer, and other chemical applications;

b. guidelines and regulations on the transport and storage of agricultural chemicals;

c. increased reliance on integrated pest management to reduce agricultural biocide applications;

d. more research on the fate of agrochemicals in the environment, particularly in soil and water; and

e. better insight into the relationship between agrochemicals and water quality.

OTHER INSTREAM USES

Fisheries and wildlife populations and habitats depend heavily on a functional water system. However, their officially recognized water requirements have only been incidental to other uses. This is largely because in the province's pioneer days, emphasis was on accelerated economic development. As most of the economic activities were related to offstream water use, instream uses, with the exception of hydroelectricity, were not recognized as worthy of protection.

The public is becoming increasingly concerned with other water-related values, such as esthetics and recreation, and is calling for diversification of the economy. Thus it is necessary that, in addition to the conventional economic tools, nonmarket criteria be used in valuing natural resources. New social preferences, and the maintenance of biological diversity, are emerging criteria which, if adopted, could give greater protection to neglected instream uses.

FISHERIES

Commercial and recreational freshwater fisheries make a significant contribution to the B.C. economy. This sector also plays an important role in supporting native lifestyles. Rivers, streams, lakes, and other water systems on which fish depend for their life processes form an integral part of fisheries habitat. Consequently, it is important that remaining habitat should be protected from destruction or degradation to the level possible, or even enhanced, because of its importance to the provincial economy.

Fish habitats are susceptible to harm from a variety of sources including direct discharges from industrial, municipal, and agricultural effluents, forestry, mining, transportation corridors, as well as construction work in riparian habitats (Canada, 1989). Acid rain and other airborne pollutants can also threaten fish habitats (*ibid.*).

Fisheries-related legislation is multi-jurisdictional, involving provincial, national, and international concerns. Fish in coastal and inland waters are a federal responsibility, but come under provincial jurisdiction when taken out of the water. Because some commercially important fish, such as salmon and rainbow trout, spend part of their lifecycle in the ocean, water management for fisheries has international implications as well. Because of poor data on historical fisheries runs and catch levels, it is impossible to specify with any precision what impact water and land management practices, such as mining, agriculture, urbanization, hydroelectricity, and other influences have had on fisheries.

The B.C. Water Act does not explicitly mention fisheries requirements in water allocation, but specialized water structures and diversions, which are prerequisites for water to be allocated for fisheries, are permitted (sect. 12(1); 1). As well, the Ministry of Forests Act, and the Environment Management Act, have provisions for fish habitat protection (B.C., 1990b). Further, MOE, by special agreement with the federal government under the Fisheries Act, is responsible for the management of resident and anadromous fish in the province. The ministry is to safeguard fish habitat by maintaining required streamflows, protecting water quality, and preserving riparian vegetation and rearing habitats (B.C., 1989b).

There are comparatively few water allocations which benefit fish such as in the Adams River (B.C. 1919). In this instance, the water license had to be issued "in the public interest" because the fish habitat which is protected could not be preserved under existing legislation. And in spite of frequent references to an agreement which prevents the construction of dams on the main stem of the Fraser River in order to protect fish populations, it could not be located for inclusion in this report.

Clearly, fisheries have traditionally received, and continue to receive low priority under the provincial Water Act. They need better protection, which could be facilitated by:

i. amending the Water Act to recognize instream flows as a beneficial use;
ii. regulating the timing of water flow to benefit other water users to the extent possible;
iii. protecting instream flows prior to licensing for other uses when fish are an important component of the ecosystem; and
iv. ensuring water quality--sediment load and chemical composition--especially in water systems important for fish migration, feeding, and spawning.

WILDLIFE

The aquatic environment which includes wetlands, estuaries, water and related vegetation, is important for wildlife. Wetlands are permanently or seasonally wet areas, shallow waters, lakes, river, estuarine, and coastal margins (Canada, 1987b: 26). They are the interface between land and water ecosystems, and provide substantial ecological, economic, and social benefits to both the provinces and the nation.

Wetlands are among the most productive ecosystems, providing essential habitats for waterfowl, fish, furbearers, and about a third of the wildlife species identified as endangered, threatened, or vulnerable (Canada, 1990: 31). They also support commercial and sport fishing, waterfowl hunting, trapping, recreation, water purification, groundwater discharge, and flood-peak modification (Canada, 1987b: 26). Their social benefits include recreational, educational, scientific, and esthetic values. The condition of a wetland is often an indicator of the state of the environment.

Wildlife populations and habitats have declined in the past decades (B.C. Waterfowl, 1989: 18). Drainage, and land use conversion of wetlands to agricultural, urban, and port developments, have all contributed to the depletion of the province's wetlands (Canada, 1987b). An active conservation program is essential if the provincial wetland resource is to play a meaningful role in the sustainability of wildlife populations.

Wetlands which serve as habitats for migratory birds are under joint federal and provincial jurisdiction. Migratory birds in Canada are protected by the Migratory Birds Convention Act of 1916 (British Columbia Waterfowl Technical Committee, 1989: 2), and are further protected in the province by the B.C. Wildlife Act of 1982. Currently, waterfowl are managed jointly by the Canadian Wildlife Service, B.C. Ministry of Environment, and Ducks Unlimited Canada (Canada, 1990; British Columbia Waterfowl Technical Committee, 1989).

In view of the social, economic, and ecological significance of these aquatic ecosystems, wetland conservation should be enhanced by:

a. supporting a level of wintering population of all wildlife species which would ensure viable populations;
b. improving cooperation among MOE and other agencies whose mandates influence the existence and viability of wetlands;

c. minimizing the negative impact of policies, programs, and new developments on wetlands by using regional planning to identify valuable areas, and environment impact assessment to screen interventions and mitigate undesirable effects;

d. legislating wildlife habitat protection;

e. classifying habitats according to species use, and threat, and encouraging integrated water and related land use practices; and

f. educating the public on wetland values, and involving them in management and conservation programs.

TOURISM

One of the new water uses which is inadequately represented in water and related land planning and management in British Columbia is tourism. Wilderness-oriented adventure tourism contributes $135 million to the $3 billion tourism industry in the province, and it is growing rapidly. Tourism largely depends on a pristine, unpolluted environment, and if it is to continue to attract visitors, then water is an important component of the milieu which must be sustained. Currently wilderness is not deemed to be sufficiently important to warrant a water license. Indeed, it is not mentioned in the Water Act (B.C., 1979c).

The Planning and Resource Management Branch of the B.C. Ministry of Tourism has three basic tasks. In the policy area it is required to review provincial policies related to federal-provincial initiatives, transportation issues, industrial sectors, and of all resource management agencies that affect tourism. It is also charged with the development of provincial tourism policy. In the field of resource management its mandate is to identify and represent the interests of the tourism industry in all significant resource management decisions in the province. At the planning level its task is to identify tourism development opportunities based on existing and potential market demand. Water planning is an important component of all three areas of concern.

RECREATION

The Canadian Heritage River system is a joint federal-provincial initiative that has been adopted across most of Canada. Its purpose is to protect nationally significant rivers from development. At the present time, only Alberta and British Columbia have not joined, although Alberta may do so in the coming year. The Outdoor Recreation Council of British Columbia (ORC) has repeatedly urged the province to become an active participant in this program but without success (ORC 1989a: C.4.1., p. 30).

In September 1984 the then minister of lands, parks and housing announced a provincial recreation corridor program. Of 21 water-based candidate corridors nominated for inclusion in the system since that time, four small drainages have been approved, 2 partially approved, 1 has been nominated for inclusion, and 6 are being considered (ORC, 1989b: 2). The Ministry of Parks has been successful in obtaining designation status for recreation corridors.

A single coordinator within a ministry is required if the impressive water-based recreation potentials of the province are to be realized. This person could coordinate the actions of an advisory committee composed of appropriate agencies and nongovernmental organizations to make the process of designating new corridors more effective. The Ministry of Parks or Tourism could be the logical agency to take the lead.

WASTE MANAGEMENT AND WATER QUALITY

Lakes and rivers traditionally have been regarded as repositories for wastes and pollutants. This is because of the capacity of the water system to assimilate wastes by dilution, by carrying them away from discharge points, and by biochemical processes that break down waste materials and incorporate the components into the environment (Canada, 1985b: III-7).

Although there has been significant waste treatment improvements before discharge into natural systems in recent years, the increase in the number of pollution sources often perpetuates heavy waste loads. The Lower Fraser River is such an example (Canada, B.C., and FREMP, 1988).

Pollution is more prevalent in heavily populated areas, and where there is a concentration of industries. Fish productivity in such areas is also low (*ibid.*). Although fish species respond differently to water pollution, when contaminated with dangerous levels of mercury, dioxins, PCBs, and sewage, they may be unfit for human consumption, and the affected area may have to be closed to fishing. Pulp and paper wastes, mine tailings and drainage, and industrial effluents may all contribute to this problem in the absence of proper treatment.

Water quantity and quality legislation have been developed, but operate independently of each other in the province. There are separate units for water allocation and water quality evaluation in the Water Management Branch, and in the Municipal Liquid and Industrial Waste Branch for checking on permit compliance in the Environmental Protection Division. These are all units of the B.C. Ministry of Environment. It is uncertain if this separation of functions creates problems for water managers and users. Clearly, allocation priorities should reflect water quality, and conversely, water uses should not be licensed without considering the impact on water quality.

Traditionally water quality permits were often not effectively enforced during the 1980s in the province. Brown and Rankin (198*), for example, reported that the Waste Management Branch relied on negotiation and bargaining to achieve compliance with permit conditions. This consensual compliance strategy failed to persuade habitual violators to stop polluting. Prosecution, the sanction of last resort, proved to be equally ineffective with 9 convictions in 1986 resulting in average fines of $500. At the same time, all water quality permit data, the level of compliance, and enforcement actions were withheld from the public.

This extreme level of secrecy began to be removed in July 1990. Recently, the Minister of Environment released a list of 116 industrial operations and municipalities out of a total of about 3050 permits in the province, which were either not complying with their waste management permits or were considered to be a potential pollution concern (B.C., MOE, 1990a). Although only a terse description was provided of the nature of noncompliance, further data are available from the appropriate regional office concerning details of pollution permits and current effluent characteristics. Such data, which have been routinely available to citizens of Washington State for more than a decade, have assisted public interest groups to focus attention on persistent polluters. Supported by increased staff and funding, the Ministry of Environment intends to increase the level compliance with existing permits in the future.

NATIVE USES

Water is central to the spiritual, cultural, and economic existence of aboriginal peoples. It is an important source of food and income because water and associated land and vegetation provide habitat for fish, waterfowl, game, and fur-bearing animals. It is also an important mode of transportation.

Urban and industrial developments have negatively impacted on aboriginal lifestyles. By changing the quantity, quality, and distribution of water and related resources, development projects have altered the hunting, trapping, and fishing patterns of native people. As a consequence, there has been an increase in the incidence and intensity of native peoples' protests over water and land claims in the attempt to regain control over their traditional territories.

The affirmation of native peoples' rights to water and related resources would demand an accommodation of aboriginal interests in resource management. This could be facilitated by:

a. settling aboriginal land claims. Protecting native rights to water in B.C. must be considered in the wider national context, because native issues are mostly under federal jurisdiction. However, there are special federal-provincial constitutional agreements on aboriginal issues. The recent Yukon Land Claims Settlement, and other court decisions (Bartlett, 1988) have affirmed the unique status of aboriginal water rights; and by

b. legislating the role of aboriginal people in the planning and management of water resources where they are stakeholders.

GROUNDWATER

Groundwater quantity and quality are largely a function of land and water use practices. Industrial actions in forestry and agriculture as well as urbanization, industrialization, and waste disposal practices all affect groundwater. Fortunately, there are currently no major areas of groundwater mining in the province.

In terms of management, the B.C. Water Act does not permit licensing of either groundwater quantity or quality. Generally, this has not been a problem to date as the well drilling profession has voluntarily provided information on roughly 50,000 wells throughout the province whose locations are known. In addition, 750 water well location maps, and 360 groundwater quality overlay maps showing well locations with water quality analyses, are on file. A network of 145 observation wells is currently being maintained in the province to monitor changes in water levels and trends in quality. These are primarily located in areas where groundwater is used extensively for potable water supplies and irrigation purposes.

In the United States it is estimated that 2.7 to 6% of the rural water supplies in the nation are contaminated by excessive nitrate. This can cause a life threatening condition in infants and it is suspected of causing cancers in adults as well. Pesticides are also a groundwater problem in some agricultural areas (Freshwater Foundation, 1986 and 1988). The long-term result of the coexistence of nitrates, pesticides, and other chemicals is unknown.

The major British Columbia groundwater problem at present relates to quality degradation. Although only sketchy data are currently available, the level of nitrates is known to be increasing in areas such as the lower mainland, Osoyoos, and Grand Forks. This is normally caused by inadequate or poorly managed septic systems, animal feedlots, manure storage facilities, and excessive quantities of nitrogen-rich fertilizers. As groundwater testing is extended throughout the province, progressively more areas of contamination may be discovered, largely in agricultural areas or in the vicinity of landfills. Another problem is associated with a few localized areas of salt water intrusion in the Cowichan area and sporadically in the Gulf Islands.

Thus groundwater management appears to be a potentially important problem area in future. Although a 1983 amendment to the Water Act permits the government to regulate groundwater, this provision has not been used (B.C., 1979c: sect. 5).

A limited response to this problem is required in which legislation is adopted that permits groundwater licensing by the Ministry of Environment for the quantity of water used and the quality of water discharged to the soil. At the same time, reconnaissance investigations should be undertaken in the areas of highest potential contamination. If serious levels of degradation are detected, appropriate management strategies can be developed in cooperation with other ministries. Ultimately, sustainable management policies will be required for specific aquifers, agricultural regions, or perhaps political units based on the integrated actions of the Ministry of Environment, all land use ministries, and water users in the areas affected. In some instances, new water and land use policies may be necessary for agriculture, forestry, other industrial sectors, and urban communities to protect aquifers.

RIVER BASIN PLANNING

Federal-provincial cooperation in managing river basins in British Columbia during the 20th century has been limited. Initially, there was action concerning engineering and flood control aspects of the Columbia River to enable the development of hydroelectricity. And a comparatively comprehensive preplanning study was undertaken by both senior levels of government in the early 1980s in the Thompson basin but never expanded into a full study. Subsequently, Environment Canada has been compiling internal overview documents of available data and development opportunities in a number of watersheds for its own use.

In spite of the importance of river basins to British Columbia, the era of river basin planning initiatives which swept across North America and much of the world during the 20th century never had much of an influence in this province. But this was not due to an absence of federal interest. Indeed, river basin planning was formally promoted under the Canada Water Act of 1970. This legislation allowed the federal government to enter into agreements with provinces to promote planning for large watersheds. The approach was intended to develop flexible plans which are adaptable to changing circumstances, to involve the publics in a meaningful way, and to consider the role of coordinated actions in meeting multiple objectives. British Columbia worked with Environment Canada on part of the Okanagan Valley, a comparatively small drainage, in formulating a management plan. And there was federal-provincial cooperation in the small portion of the Yukon basin located in British Columbia in the 1980's.

There have also been two additional ad hoc cooperative institutional mechanisms established to examine the development potential of specific basins, the Flathead and Skagit. Otherwise, the province has opted to work independently of the federal government in planning and managing the other river basins of the province. Instead of attempting a synthesis of management opportunities, and making trade-offs among these throughout the major drainages, provincial management responsibilities have been divided among agencies which deal exclusively with individual resources: forests, minerals, fish, wildlife, agriculture, water, energy, parks, tourism. These interests have not been reintegrated for management decisions by river basins. Indeed, few other agencies except for B.C. Hydro, the Water Management Branch of environment, and federal and provincial fisheries consistently organize their data by river basins. And river basin study teams empowered to synthesize development options, and make recommendations to government, have never been created except for some aspects of the Okanagan, Flathead, and Skagit basins. Unlike the Prairie and Maritime provinces where federal resources to assist with water planning have been actively solicited, federal expertise and funding have never been systematically used by British Columbia to proactively consider joint development opportunities in the major provincial drainages. Given this institutional vacuum, decisions concerning the provincial rivers have largely been based on project-by-project approvals.

The Ministry of the Environment has completed the most extensive assessment of river subbasin plans in the province to date. In total, critical biophysical appraisals have been completed in 16 of 43 drainages throughout the province where management conflicts have arisen. These deal with water and air quality, fish, wildlife, and noise. The studies are being conducted under the mandate of the Environment Management Act (B.C., 1981). Section 1 of the act defines environment in a biological sense, with respect to air, land, and water. Section 2 empowers the minister of environment to plan, research, and investigate any aspect of the management, protection, and enhancement of the environment.

Although a strategy has been developed for undertaking such studies over the past decade (O'Riordan, 1983), there is little grounds for optimism that this work will be expanded quickly throughout the province. The ministry has been unable to fully implement this program, nor develop the resource inventories required for rapid assessment of small drainages. At present, there is no capacity to assemble a comprehensive overview of environmental values throughout the provincial river basins within the immediate future.

The consequence of this history is that uneven data bases exist today among provincial and federal resource agencies, which serve as the basis for determining long-term development priorities for the provincial river systems. None of the agencies has had resources to prepare a long term plan outlining its bargaining position with which it can debate the merits of alternative development options promoted by other agencies. Indeed, no federal or provincial government agency, has attempted to create a province-wide management plan for its area of responsibility in the major rivers of British Columbia based on solid data and widespread public debate.

PUBLIC INVOLVEMENT

Public input should be solicited for criteria setting, objectives determination, and use designation in water and related resource management. This is because the public is willing to, and capable of, making a substantial contribution to resource allocation decisions. Public consultation can strengthen resource management by broadening the scope of issues, providing a wealth of expert advice, local knowledge, and exposing alternatives which, otherwise, might be overlooked. It also facilitates dissemination of information, and reduces misapprehension and conflict.

Although there is a fair degree of public participation in public policy formulation, the process could be improved by:

a. ensuring greater public involvement in planning, implementation, and monitoring of policies and programs;
b. assisting the public in making informed decisions on a development proposal by granting easy access to all relevant information; and
c. promoting the formation and operation of public advisory committees to involve the public in program development and decision-making processes.

A SUMMARY ASSESSMENT

The legislation and institutions which govern water planning and management in British Columbia are a product of the changing goals, objectives, and values of society during the 19th and 20th centuries. They served the province well by opening up wilderness areas, creating jobs, and developing the economy. But the time for the single-purpose development has passed and the province is entering a new era of integrated resource management. Whereas corporate profitability, jobs, and government tax revenues were the overriding decision criteria, these are being augmented by new concerns. They include: maintaining ecological and economic diversity and stability; minimizing economic, social, and biophysical side effects of development projects; improving mechanisms of determining and including social preferences in decision-making; and using risk aversion to determine development options.

As the province begins experimenting with means to implement a new approach to resource stewardship, based on sustainability within an integrated resource management framework, several facts should be kept in mind.

1) In the interest of industrialization, large water allocations have already been made for certain out-of-stream uses in specific basins;
2) Comparatively, few allocations have been made throughout the province for instream uses such as fisheries, wildlife, birds, recreation, and tourism;
3) Currently there are not enough personnel in the B.C. Ministry of Environment and other resource agencies to collect and analyze the data necessary to understand the dynamics of river basins and aquifers in the province, as well as the cumulative effects of development on these systems;

4) Many existing agency personnel have neither training nor experience in working in public forums to achieve mutually agreeable management strategies among competing water users; and

5) The publics who consider themselves as stakeholders in some component of the water and related biophysical resources of the province have never been given an opportunity to express their long-term management preferences for the river basins of the province.

For these reasons, the transition to institutions which promote sustainable management from the current single-purpose approach will be prolonged, frustrating, and costly. But the potential payoff to future generations is well worth the effort if sustainable resource and industrial management systems can be fashioned to form a stable basis for the British Columbia economy for the 21st century. Some desirable changes to make this possible are discussed next.

THE WATER ACT

This legislation requires a complete restructuring and better integration with other provincial legislations which govern the use of forests, agriculture, lands, tourism, parks, fisheries, wildlife, and waste management. In addition, the restructured act should be flexible enough to respond to changing policy contexts and new demands, promote resource conservation, provide incentives for efficient water use, and reinforce the concept that water is a scarce and valuable resource. The revised act should include the following provisions.

A Planning Mandate. The Ministry of Environment needs to be empowered to analyze existing water resources, emerging quality and quantity problems, the physical limits of development, and to undertake planning.

The provincial Water Act is the principal legislation used to adjudicate applications for water use, although federal fisheries' concerns may influence the final decision. This approach to water allocation by river basins is incomplete and inadequate. When the Water Management Branch completes its current program of computerizing available water supply and allocation data, it will need to develop a new allocation system. This should sanction the active involvement of all stakeholders--agriculture, urban, forestry, mining, fisheries, wildlife, tourism, recreation, parks, and other water users--in establishing base flow requirements by subbasin, permissible levels of disturbance to base flows, and acceptable uses. A system that considers the needs of all users prior to development would constitute a major advance in the management of British Columbia rivers.

Another important deficiency in the current water allocation system is that it is reactive. To correct this, the Minister of Environment should further improve the current planning approaches, and also consider other land and water management issues which are currently ignored in the Water Act. Such an approach would enable the province to evaluate a range of alternative allocations based not only on hydroelectricity, but also on other resource uses, long before specific developments are proposed. For example, the Northwest Power Planning Council placed 44,000 miles of the streams in the Columbia Basin off-limits to hydroelectricity in 1989 to protect fisheries habitat (Lee and Kneese 1989: 1). Proactive planning of this nature could be applied to many resource interests in British Columbia to clarify in advance where specific uses are acceptable or desirable.

New Priorities. The uses which are not currently recognized as legitimate in the act--fish, wildlife, tourism, and recreation--should initially receive preferential treatment in future water allocations. This special status should continue until these ignored instream uses have been adequately inventoried in terms of the potential of the provincial river systems to support them. Future water allocations within all basins should be made in light of the commitments already made for various water uses with specific basins and throughout the province.

Transfer of Water Rights. Two systems are desirable to permit a change among holders of water rights. The first occurs when water is no longer used because, for example, a mine closes. In such instances, water associated with the license reverts to the crown. This requires field investigation to determine the current level of water use.

In other circumstances, there will be changes in the profitability of different industries over time. The new legislation could permit the trading of all or part of active water licensing so that willing buyers and sellers could exchange rights among approved water uses. Such a reliance on the market in allocating water resources could complement the present regulatory system especially where the ministry has insufficient resources to enforce compliance with allocation permits, or where water uses are well defined, and negotiation costs are not prohibitive. Potential trades should be subject to approval by the Ministry of Environment to ensure that all social needs are considered before sales are finalized.

COMMUNITY WATERSHEDS

The policy of allowing integrated resource management in community watersheds on crown land in British Columbia has been a continuing source of conflict. Neither the Ministry of Environment nor the Ministry of Forests has the necessary resources to prepare integrated watershed management plans which are intended to safeguard public water supplies for these areas. Either funds and personnel to do this work should be made available, or no new forestry and mining operations should be allowed in areas where domestic water supplies are threatened until plans are in place to protect community water supplies.

HYDROELECTRICITY

British Columbia Hydro has traditionally had a competitive advantage over governmental resource management agencies because of its comparatively large level of funding and personnel available for policy and project-related studies. As a result, the utility identified the major hydroelectric basins and development sites long before other governmental agencies had funding and manpower to assemble comparable inventories for competing water and land uses.

The threat which hydroelectric development posed to competitive resource management options in the rivers of British Columbia was dramatically reduced in 1990 by twin policies adopted by B.C. Hydro. These relate to its new goals of minimizing environmental degradation and of promoting energy conservation by a variety of means. Hopefully, other provincial and federal resource agencies can use the first half of the 1990s to assemble inventories of the potential which specific river basins of the province have to serve a variety of needs. Such data will be needed to make the difficult decisions on the long-term allocation of water to permit sustainability of competing uses in coming years.

Now that B.C. Hydro has adopted its new energy policy, the major unknown factor in terms of future hydroelectric development in the province are the priorities of the minister of energy, mines, and petroleum resources and the provincial cabinet. It is also unknown whether the government priorities are the same as the new B.C. Hydro priorities. To the present time, British Columbia publics have not been given the opportunity to debate the comparative merits of alternative hydroelectric development scenarios, and all other development options, for provincial rivers. If a new agency were empowered to begin the process of formulating sustainable resource use plans for the major provincial rivers as is suggested below, a forum to consider this important policy question would be available for the first time.

AGRICULTURE

Agricultural practices exert pressure on water quality and quantity. In semiarid areas, such as in the southern interior, there is inadequate water supply to meet the various demands. New priorities are needed to guide water allocation for farm and nonfarm uses. There is also inadequate legislation to regulate water quality. The provisions under the Pest Control Act and Waste Management Act do not cover all farm and related practices. Application, storage, transport, and disposal of manure, fertilizer, and pesticides are examples of where stricter regulation is required for sustainable water management. And the proposed committees representing the agricultural community which would adjudicate water-related complaints also appears to be a useful innovation.

FORESTRY

Traditionally, timber harvesting practices have been detrimental to other forest-related resources. Normally, comparatively little attention has been given to other values such as fish and wildlife populations, habitat protection, recreation, tourism, and esthetics. In future, it should be necessary to consider such forest-related uses more openly, as well as to predict the hydrological consequences of forestry practices in an effort to understand the consequences of the harvesting on the sustainability of other resources and industries.

PUBLIC INVOLVEMENT

Traditionally, the Province of British Columbia has created discretionary ministerial requirements to consult the public on most resource development decisions. The regulatory ministries have strong linkages and ongoing consultation with the industrial groups which they control. But public hearings normally are only held when groups of citizens become so disturbed by potential projects associated with forestry, hydroelectricity, mining, parks, or other changes that a public forum of one sort or other is necessary to defuse the situation.

Probably, most important is the wide range of decisions that can be taken by affected provincial and federal government ministers without consulting the affected publics. The 1987 Alcan decision exemplifies how citizens with important social, economic, and environmental concerns can be excluded from a decision making process. Nor can citizens use the courts to be heard in such environmental matters, due to legal technicalities such as the difficulty of getting legal standing, burden of proof, and lack of intervener funding. Although the forthcoming Federal Environmental Assessment Act may reduce the probability of such secrecy when federal responsibilities are involved, there have been no comparable provincial legislative initiatives to redress this problem. As a consequence of the current institutional system, British Columbia citizens have never been given the opportunity to comment on most management policies which have implications for resource sustainability.

GROUNDWATER

This component of the provincial resource base should be included in the Water Act. In the isolated areas of potential groundwater contamination in British Columbia, more manpower and funding is required on a pilot-study basis to determine what needs to be done to control contamination. This experience should then be used to establish the degree of government regulation which will be required to manage groundwater on a sustainable basis. Better control may be required over herbicides, pesticides, agricultural chemicals and wastes, industrial and municipal wastes, and other sources of water degradation.

RISK, UNCERTAINTY, AND DEVELOPMENT OPTIONS

A strong case can be made for not fully licensing the water in the subbasins of the province. Probably most compelling among these is the unpredictable effect which current anthropogenic atmospheric changes might have on water availability in the 21st century (Moss and Lins, 1989). For this reason, as well as for the possibility of changing patterns of water demand, it would be prudent to adopt a strategy of not overcommiting the available water resource. By keeping some water in reserve until the ability to forecast runoff improves, the probability of achieving goals established for sustainable water and water-derived services stand a better prospect of being met.

AGENCY FUNDING AND PERSONNEL

An aspect not sufficiently investigated in this report is the level of staffing available to undertake the suggested planning and management initiatives. However, based on the discussions undertaken for this study, it is clear that the ministries of tourism, and environment require substantially more manpower and funding if improved management systems are to be undertaken. No doubt, the other resource agencies also would be hard pressed to do more with existing resources. Any recommendations to introduce sustainable management systems in the province will need to consider the kinds of expertise needed to do the work as well as the adequacy of present agency budgets to undertake the work.

RIVER BASIN PLANNING

Irreversible decisions will continue to be made on the future use of British Columbia rivers. At present, there are limited checks and balances in the British Columbia institutional system to ensure that a full public debate of the critical values involved will be possible. The current institutional system does not permit a provincial or region-wide assessments of water and land development alternatives in all river basins of British Columbia. Without an appropriate institution to undertake this work, and the necessary intelligence, the province is ill-prepared to make any decisions on the desirability of potential development options.

Three provincial institutions have played a major role in planning and managing British Columbia rivers during the 1980s: the Ministry of Environment, B.C. Hydro., and the B. C. Utilities Commission. Perhaps none of these is the appropriate body to make the necessary trade-offs among potential uses as the province begins to experiment with institutions to implement sustainable management.

The Ministry of Environment appears to be the strongest candidate for this task because of its traditional role as the adjudicator in making trade-offs among competing water uses and its experience in formulating subbasin plans. But environment has a potential conflict of interest, because it also acts as an environmental advocate by protecting fish, wildlife, and air and water quality, much like other provincial ministries which are also proponents. As a result it could be argued that the ministry might have a bias in making trade-offs, or that its ability to ensure the sustainability of the interests which it represents is not compromised by the need to reach agreement with other stakeholders.

The B.C. Utilities Commission (BCUC) has reviewed and certified the construction and operation of major hydroelectric projects during the 1980s (B.C., Revised Statutes, 1980). In rejecting the proposed Site C dam as unnecessary in 1983, it had a major impact on the Peace River basin. However, the BCUC mandate is too narrow, and it also has a potential conflict in its role of regulating hydroelectric development.

Thus, what is needed is a new professionally staffed, permanent river planning and management agency comprised of broadly trained resource managers which does not regulate a specific component of the environment. Its role would be to develop sustainable management plans for water and related resources in each major provincial river basin and subbasin as well as for the system of provincial rivers. Such a body could report directly to the Sustainable Development Committee of cabinet. It would clearly be a strong candidate to designate special round-table type panels for specific basins under the sustainable development initiative in the province (B.C. Task Force 1989: 21-26).

The agency should combine industrial, governmental, and public interest groups which promote development, preservation, and sustainability in its organization. In the early phases of its work, the committee should be directed to conduct and solicit research and prepare background documents on the current situation from the perspective of the major actors involved: industry, government, labor, and other interests. Then public hearings and workshops could be held throughout the province. Its immediate mandate should be to give the provincial government advice on the range of feasible planning and development options for all of the major provincial river basins before further major decisions are taken. Over the long term permanent, but small, planning and coordinating bodies would be needed for each major provincial drainage. These should act as clearing houses for relevant information and provide a forum for debate and conflict resolution related to ongoing management concerns among all interested parties. They could also liaise with affected interests on environmental and socioeconomic matters which affected major rivers.

To continue the current project-by-project approval process would run the risk of impairing, or destroying, potentially viable development options. The institutional change suggested here would begin the process of formulating policies and plans which would consider all sustainable management options throughout the system of provincial rivers. But the establishment of new priorities on the relative importance of water and related resource uses also implies major shifts in the machinery of government. Because water cuts across many aspects of government policy, the new agency could also assist in selecting an appropriate balance of uses within specific river basins and then in coordinating sustainable management policies among the affected ministries.

INTEGRATING SUSTAINABLE DEVELOPMENT POLICIES

There are a variety of factors in the current legislative and institutional system which impede the rapid introduction of sustainable development policies for water and related resources. These include: a lack of clear management objectives, the consideration of limited social values in planning decisions, bureaucratic politics, and inadequate information (Canadian EARC, 1990: ix).

In addition to the required direct legislative and institutional changes, complementary policies are also required for a comprehensive approach to sustainable water management. Examples of the complementary policies include: the setting of sustainable water management and related resource development objectives, a larger commitment to environmental science, improved public consultation mechanisms, more effective evaluation indicators, conducting post audit assessments, and increasing the logistical support of relevant agencies.

RECOMMENDATIONS

1. Legislate Instream uses. The B.C. Ombudsman recommended that a comprehensive legislative foundation should be provided to ensure fairness, certainty, and predictability in integrated resource management (B.C., Ombudsman's Report, 1988). To do so, a legal framework should be established in situations where conflicts are anticipated. Legislating instream uses is a means of providing a more level playing field for all major water users. Amending the relative priorities of competing uses in the Water Act is another.

2. A nonpartisan agency, independent of resource development interests, should be created to oversee the planning and implementation of provincial water policies. The current discretionary referral process among provincial interests should be formalized.

3. Negotiated Agreements. In each river basin, or major subbasins, a committee consisting of all governmental and private stakeholders in the water resource should negotiate compromise river basin development agreements. This would be in line with the Ombudsman's recommendation for a consensual conflict resolution mechanism, one which relies on negotiation rather than litigation, and on creative alternatives in reconciling competing interests. In this approach the new river basin management body could act as a facilitator or a neutral mediator, to ensure balanced decisions.

3. If MOE continues with its current discretionary allocation process, decision making should occur within a more open and structured framework to enhance public confidence in the impartiality of its judgments. To do so, the criteria for allocation decisions should be made explicit and reasons for decisions taken made public.

4. Although beyond the scope of this report, there has been considerable experimentation with alternative institutional forms for river basin and regional water management in North

America and elsewhere during the 20th century, and particularly in the 1980s. No doubt, some of these will inherently be better than others in terms of their applicability in British Columbia. These experiences could provide valuable lessons to reduce the cost and time required to begin the process of learning how to manage the water and related resources of British Columbia in a sustainable manner.

5. One of the greatest challenges in moving to a system of sustainable water and related land management is to be able to measure the degree to which new policy goals have been accomplished. To do so, some landmarks of success would be desirable, such as a system of indicators which report changes in key variables, or periodic state-of-the-environment reports. An authoritative agency, which is free of political influence, would be the most reliable unit to assure that the assessments are reliable.

REFERENCES

Bartlett, R.H. 1988. *Aboriginal Water Rights in Canada: A Study of Aboriginal Title to Water and Indian Rights.* Calgary, AB: Canadian Institute of Resources Law, Univ. Of Calgary.

Barton, Barry. 1987. "Water Resources Projects: Western Canada," pp. 60-67. In: Border Waters: U.S.-Canada Transboundary Management. Proceedings of a 1986 Conference. 49th Parallel Institute for Canadian-American Relations.

Baxter, R.M. and Pierre Glaude. 1980. "Environmental Effects of Dams and Impoundments in Canada: Experience and Prospects." *Canadian Bulletin of Fisheries and Aquatic Sciences* 205: 34 pp.

Bosch, J.M., and J.D. Hewlett. 1982. "A Review of Catchment Experiments to Determine the Effect of Vegetation Changes on Water Yield and Evapotranspiration". *Journal of Hydrology* 55: 3-23.

British Columbia. 1989a. *Environment and Parks: 1987-88 Annual Report.* Victoria, BC: Queen's Printer.

________. 1989b. *Ministry of Agriculture and Fisheries: Annual Report 1988-89.* Victoria, BC: Queen's Printer.

________. 1988. *Water Regulation. Order in Council 889.*

________. 1987. *Ministry of Forests and Lands Annual Report, 1986-1987.* Victoria, BC: Queen's Printer.

________. 1981. *Environment Management Act.* S.B.C., Chap. 14.

________. 1979a. *Hydro and Power Authority Act. Chap. 188.*

________. 1979b. *Utilities Commission Act.* RSBC *Chap. 60.*

________. 1979c. *Water Act.* RSBC. Chap. 429.

British Columbia. Cabinet. 12 Nov. 1919. *Adams Lake, River, and Tributaries.* Order in Council 1511. Victoria, B.C.

B.C. Forestry Association and Okanagan-Similkameen Park Society. 27 May 1989. *Symposium on Selective Logging and the Environment.* Penticton, B.C.

British Columbia Hydro and Power Authority. 1990. *1990 An Introduction to the 1990 Electricity Plan.* Vancouver, BC.

British Columbia Hydro and Power Authority. Corporate Affairs. Resource Planning. 1989a. *Twenty-Year Resource Plan for the Period 1989-2008.* Vancouver, B.C.

British Columbia Hydro and Power Authority. Information Services. 1989b. "B.C. Hydro: Actual Water Rental Fee Expense for the Calendar Year 1988." Memo 9/3/1051. Vancouver, B.C.

British Columbia. Legislative Assembly. Select Standing Committee on Agriculture. 1986. *Agricultural Land Budget for British Columbia*, by Talisman Land Resource Consultants. Vancouver, B.C.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. 1990a. "Proposed Policy for Mineral Resource Development in Community Watersheds." Victoria, BC.

British Columbia. Ministry of Energy, Mines and Petroleum Resources. Energy Resources Division. Project Analysis Branch. 1982. *Guide To the Energy Project Review Process*. Victoria, B.C.

British Columbia. Ministry of Environment. 1990a. "Reynolds Releases Non-Compliance/Pollution List." *News Release* 1990:46. Victoria, B.C.

________. 1990b. "Submission to B.C. Forest Resources Commission." Victoria, BC.

________. 1989. "Acid Rain in the West." *Fact Sheet*. Victoria, B.C.

British Columbia. Ministry of Forests and Lands. 1987b. *Watershed Workbook: Forest Hydrology Sensitivity Analysis for Coastal British Columbia Watersheds*, by D.J Wilford. Interim Edition. Victoria, BC: Queen's Printer.

British Columbia. Office of the Ombudsman. 1988. *Annual Report of the British Columbia Ombudsman*. Victoria, B.C.: Queen's Printer.

British Columbia Task Force on Environment and Economy. 1989. *Sustaining the Living Land*. Victoria, B.C.: Queen's Printer.

British Columbia. Utilities Commission. 1983. *Site C Report*. Vancouver, B.C.

British Columbia Waterfowl Technical Committee. 1989. *Cooperative Waterfowl Management Plan for British Columbia*. Canadian Wildlife Service, B.C. Ministry of Environment, Ducks Unlimited Canada. Np,np.

Brown, Richard, and Murray Rankin. 198_. "Persuasion, Penalties, and Prosecution: Administrative v. Criminal Sanctions." In

Canada. British Columbia. Fraser River Estuary Management Program. 1988. *The Fraser River Estuary: An Overview of Changing Conditions*, by K. Kennett and M.W. McPhee. New Westminster, B.C.

Canada. The Canadian Council of Resource and Environment Ministers. 1987a. *Report of the National Task Force on Environment and Economy*. Ottawa, ON.

Canada. Canadian Environmental Assessment Research Council. 1985b. *Social Impact Assessment: A Research Prospectus*. Ottawa, ON: Minister of Supply and Services.

Canada. Environment Canada. 1990. *A Primer on Water: Questions and Answers*. Ottawa, ON.

Canada. Environment Canada. 1987b. *Federal Water Policy*. Ottawa, ON: Ministry of Supply and Services.

Canada. Environment Canada. Canadian Wildlife Service. Sustainable Development Branch. 1988. *The Definition of Sustainable Development*. Ottawa, ON.

Canada. Inquiry on Federal Water Policy. 1985a. *Currents of Change*, by P.H. Pierce *et al.* Ottawa, ON. Environment Canada.

Canada. Inquiry on Federal Water Policy. 1985b. *Instream Resource Values and Protection Needs in Canada*, by C.T. Hartfield and G. Smith. West Vancouver, B.C.: Hartfield Consultants Ltd.

Canadian Environmental Assessment Research Council. 1990. *The Integration of Environmental Considerations into Government Policy*, by Francoise Bregha *et al.* Ottawa, ON: Minister of Supply and Services.

Council For Agricultural Science and Technology. 1985. *Agriculture and Groundwater Quality*. Report No 103. Ames, Iowa. 62pp.

Day, J.C. and Quinn, F. (forthcoming, 1991). *Interbasin Diversion and Export: Learning from Canadian Experience*, J.G. Nelson, ed. Waterloo, Ont.: Canadian Association of Geographers.

Freshwater Foundation. 1988. *Nitrates and Groundwater: A Public Health Concern*. Navarre, MN.

Freshwater Institute. 1986. *Pesticides and Groundwater: A Health Concern for the Midwest*. Navarre, MN.

Moss, Marshall E. and Lins, Harry F. 1989. *Water Resources in the Twenty-First Century: A Study of the Implications of Climate Uncertainty*. Circular 1030. Denver, CO: U.S. Geological Survey.

O'Riordan, J. 1976. "The Public Involvement Program in the Okanagan Basin Study". *Natural Resources Journal* 16(1):177-196.

O'Riordan, J. 1983. "New Strategies for Water Resource Planning in British Columbia." pp. 17-42. In: *River Basin Management: Canadian Experiences*, edited by Bruce Mitchell and James S. Gardner. Waterloo, ON: Department of Geography, University of Waterloo.

Outdoor Recreation Council of British Columbia. 1989a. *Policy Manual*. Vancouver, B.C.

Outdoor Recreation Council of British Columbia. 1989b. "Review of the Recreation Corridor Program". Vancouver, B.C.

Percy, D.R. 1984. "Federal-Provincial Jurisdictional Issues", Appendix D. In *Water Law in Canada*, by H. Rueggeberg and A.R. Thompson. Research Paper No.1. Inquiry on Federal Water Policy. Ottawa, ON: Environment Canada.

Rueggeberg H., and A.R. Thompson. 1985. *Water Law in Canada*. Research Paper No.1. Inquiry on Federal Water Policy. Ottawa, ON: Environment Canada.

Technical Committee for the Long-Range Transport of Atmospheric Pollutants in Western and Northern Canada. 1987. *Interim Target Loadings for Acidic Deposition in*

Western Canada: A Synthesis of Existing Information, by ESSA Environmental and Social Systems Analysts Ltd. and Concord Scientific Corp. Np, np.

United States. National Academy of Sciences. National Academy of Engineering. Division of Earth Sciences. Joint Panel on Problems Concerning Seismology and Rock Mechanics. 1972. *Earthquakes Related to Reservoir Filling*. PB 208 327. Springfield, VA: National Technical Information Service.